Question 8

40CFR60, APP. B, PS1
FACTORY CERTIFICATION
CONTINUOUS OPACITY
MONITORING SYSTEM (COMS)

LS541
LS541-0428

15-Oct-96

PREPARED FOR:
THE HOOVER COMPANY
101 E. MAPLE STREET
NORTH CANTON, OH.

PREPARED BY:
MONITOR LABS, INC.
76 INVERNESS DRIVE, EAST
ENGLEWOOD, COLORADO 80112

INSTRUMENT TESTED BY: ERNEST RAY KILLIAN DATE: 15-Oct-96
Monitor Labs, Inc.

CERTIFICATION PREPARED BY: Ernest Ray Killian DATE: July 14, 1997
Monitor Labs, Inc.

OPACITY CERTIFICATION REPORT

MONITOR LABS

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P/N 80039868- 2
Revision D

Printed In The USA

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I. INTRODUCTION

This report certifies the Continuous Opacity Monitoring System specified in "Instrument Description" in accordance with the requirements of USEPA 40CFR60, Appendix B, Performance Specification 1.

II. INSTRUMENT DESCRIPTION

Customer Name:	THE HOOVER COMPANY
Facility Location:	NORTH CANTON, OH.
Instrument Manufacturer:	MONITOR LABS
Instrument Model No.	LS541
Instrument Serial No.	LS541-0428
Date Inst. Tested:	15-Oct-96

III. SUMMARY OF TEST RESULTS

		USEPA Specification	Results	
Calibration Error (%)	Low	<=3%	0.56	%
	Mid	<=3%	0.88	%
	High	<=3%	0.48	%
Response Time		<= 10 seconds	2.47	seconds
Optical Alignment Sight Test		Completed	pass	

IV. DESIGN SPECIFICATIONS

IAW 40CFR60, App. B, PS1 , 6.1 the following tests were performed to satisfy the design specification requirements.

Test Unit Serial No.	LS541-0426			
Date of Test:	19-Sep-96			
Date Manufactured:	10-Sep-96			
Peak Spectral Response		500-600 nm	560.00	nm
Mean Spectral Response		500-600 nm	561.83	nm
Angle of view		<=4 degrees	3.8	degrees
Angle of Projection		<=4 degrees	2.9	degrees

IV. TEST PROCEDURES

A. OPTICAL ALIGNMENT SIGHT TEST

The LS541 is equipped with through the lens alignment and a lit target on the case side of the reflector. Viewing through the lens alignment, it is possable to verify and if necessary, adjust the instrument alignment at any time during operation. Using the lens alignment, an operator sights across the stack to the reflector. By turning the alignment bolts located on the flange as mounting hardware, an operator can center the reflector in the light beam using the cross hairs on the telescope and the back lit reflector. To conduct the test the test unit was placed on the gimball fixture and set to zero degrees horizontal and vertical. The transceiver is then calibrated for a pathlength of 8 meters.

Rotational Misalignment- A neutral density filter of approximately 10% opacity is inserted into the light path and the transceiver output is recorded. The gimballed fixture is then adjusted to show horizntal misalignment of 2% opacity. The transceiver alignment telescope (bullseye) misalignment is then verified. The horizontal is then adjusted to indicate zero using the lens alignment and the transceiver output is verified to be the same as its initial reading.

Lateral Misalignment- Using the same configuration as above. the reflector assembly is moved laterally until the transceiver output indicates 2% opacity Misilignement is verified using the transceiver telescope (bullseye).

B. CALIBRATION ERROR TEST

The Calibraion Error test is reformed in accordance with Paragraph 7.1.4. of the 40CFR60, App B, PSI at the Monitor Labs facility in Englewood, Colorado. Low, mid and high range calibration filters are used. Fifteen non-conseutive test are completed using the three calibration filters (five readings with each filter). The calibration error is represented by the sum of the mean differences plus 95 percent confidence interval expressed os a persentage of the known filter value. The initial certification of the neutral density filter is preformed by the National Bureau of Standards.

C. RESPONSE TIME TEST

The response Time test is preformed in accordance with Paragraph 7.1.5. of 40CFR60, APP B, PSI. The high range calibration filter is inserted into the light path five times. The upscale response time is the time it takes the system to respond to 95% of the filter value when the filter is inserted into the light path. The downscale response time is the time it takes the system to respond to 5% of the filter value when the filter is removed from the light path.

D. SPECTRAL RESPONSE

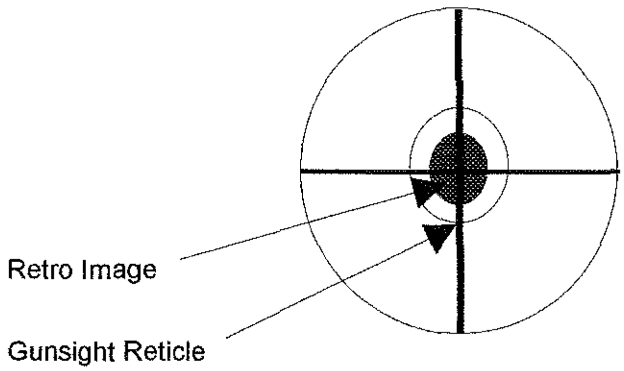
The transceiver in test is mounted on a Jerral Ash monochrometer, Model 32-415. The monochrometer is designed to measure the sprectral response of the transceiver's electronics and electro-optical components. This is accomplished by reflecting light through the monochrometer and into the transceiver in intensities from 300 nm to 800 nm in 20 nm increments. The transceiver output results are recorded. The test is repeated with the return mirror blocked thereby negating any errors that may be caused by internal reflections in the monocrhometer. The transceiver output results are recorded. The results of the spectral response analysis are provided in the spectral response data sheet.

E. ANGLE OF VIEW AND ANGLE OF PROJECTION

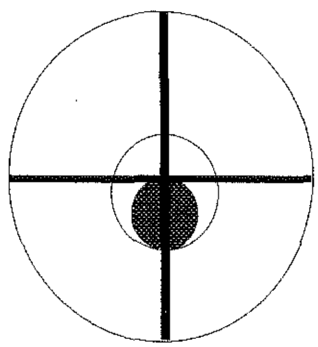
The angle of view and the angle of projection are primarily a function of the basic optical component design and are not subject to any significant changes. The AOV test was preformed IAW section 6.3 of 40CFR60, App. B, psi and AOV test was preformed IAW section 6.4 of 40CFR60, App. B, PSI. FOR the purpose of compliance to 40CFR60, App B, PSI, AOV and AOP curves have been included.

PROJECTOR UNIT MISALIGNMENT TEST

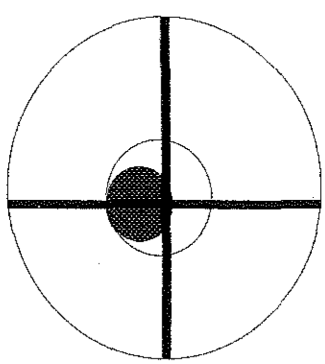
Image as viewed from optical head alignment sight.



Properly Aligned



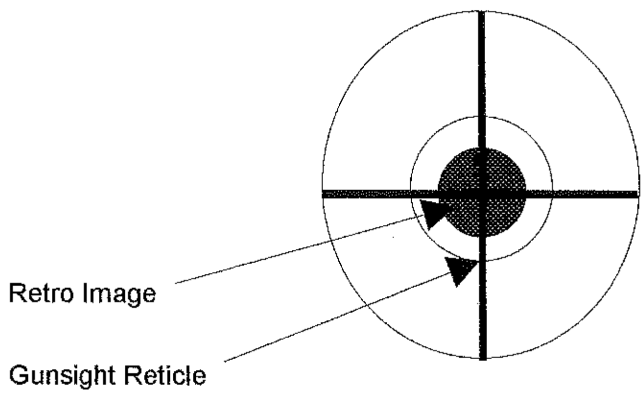
Vertical Misalignment



Horizontal Misalignment

REFLECTOR UNIT MISALIGNMENT TEST

Image as viewed from optical head alignment sight.



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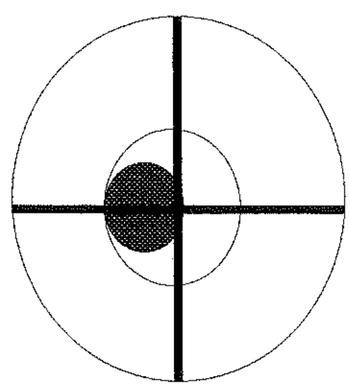


Lateral Misalignment

CALIBRATION ERROR DETERMINATION

Person Conducting Test	ERNEST RAY KILLIAN	Analyzer Manufacturer	MONITOR LABS
Affiliation	Monitor Labs, Inc.	Model/Serial No.	LS541-0428
Date	15-Oct-96	Location	NORTH CANTON, OH.
Monitor Pathlength, L1	1.824 m	Outlet Pathlength, L2	2.440 meters
Monitoring System Output Pathlength Corrected?	Yes x No	OPLR =	0.669

Calibrated Neutral Density Filter Values:

Desired Optical Density (Opacity):

Low-Range	0.100	(20.00)
Mid-Range	0.400	(60.00)
High-Range	0.900	(87.50)

Path Adjusted Optical Density (Opacity):

			Tool No.
Low-Range	0.060	(16.820)	562
Mid-Range	0.291	(59.199)	1459
High-Range	0.629	(85.605)	517

Run Number	Calibration Filter Value (Path-Adjusted Percent Opacity)	Instrument Reading (Opacity), percent	Arithmetic Difference (Opacity), percent		
			Low	Mid	High
1-Low	16.820	16.400	0.420		
2-Mid	59.199	60.000		0.801	
3-High	85.605	85.300			0.305
4-Low	16.820	16.400	0.420		
5-Mid	59.199	60.000		0.801	
6-High	85.605	85.200			0.405
7-Low	16.820	16.400	0.420		
8-Mid	59.199	60.000		0.801	
9-High	85.605	85.300			0.305
10-Low	16.820	16.800	0.020		
11-Mid	59.199	60.100		0.901	
12-High	85.605	85.100			0.505
13-Low	16.820	16.400	0.420		
14-Mid	59.199	60.000		0.801	
15-High	85.605	85.300			0.305
Remarks:	Arithmetic Mean (Equation 1-2)	x	0.340	0.821	0.365
(1) Calibration Errc <= 3% Opacity.	Standard Deviation (Equation 1-3)	Sd	0.179	0.045	0.089
	Confidence Coefficient (Equation 1-4)	cc	0.222	0.056	0.111
	Calibration Error % (Equation 1-5)	Er	0.562	0.876	0.476

III. CALIBRATION ERROR TEST DATA SHEET

(*Enter data in the "Instrument Output" blocks.)

Run No.		Instrument Output
0	**zero**	0.10
1	**low**	16.40
2	**mid**	60.00
3	**high**	85.30
4	**low**	16.40
5	**mid**	60.00
6	**high**	85.20
7	**low**	16.40
8	**mid**	60.00
9	**high**	85.30
10	**low**	16.80
11	**mid**	60.10
12	**high**	85.10
13	**low**	16.40
14	**mid**	60.00
15	**high**	85.30
16	**zero**	0.10

II. CALIBRATION FILTER SELECTION DATA SHEET

A. Desired attenuator optical density based upon instrument span:

		Opacity %
Low	0.100	20.000
Mid	0.400	60.000
High	0.900	87.500

B. Nominal (ideal) optical density based upon desired value x (L1/L2):

		Opacity %
Low	0.075	20.567
Mid	0.299	60.189
High	0.673	87.411

C. *Enter Actual O.D. Values:

	Optical Density	Opacity (%)	Tool No.
*Low	0.0598	16.820	562
*Mid	0.2911	59.199	1459
*High	0.6294	85.605	517

Audit Quarter: Q4 1996

Span Value (% Opacity)	Calibrated Attenuator Optical Density/Opacity					
	Low-range		Mid-range		High-range	
40.000	0.050	11.000	0.100	20.000	0.200	37.000
50.000	0.100	20.000	0.200	37.000	0.300	50.000
60.000	0.100	20.000	0.200	37.000	0.300	50.000
70.000	0.100	20.000	0.300	50.000	0.400	60.000
80.000	0.100	20.000	0.300	50.000	0.600	75.000
90.000	0.100	20.000	0.400	60.000	0.700	80.000
100.000	0.100	20.000	0.400	60.000	0.900	87.500

RESPONSE TIME DETERMINATION

Person Conducting Test:	ERNEST RAY KILLIAN	Analyzer Mfgr.	MONITOR LABS
Affiliation:	Monitor Labs, Inc.	Model / Serial No.	LS541-0428
Date:	15-Oct-96	Location	NORTH CANTON, OH.

High Range Calibration Filter Value:
(Optical Density) 0.629

Actual Optical Density (Opacity) (87.500 %)
Path Adjusted Optical Density (Opacity) (85.605 %)

Upscale Response Value (0.95 x filter value) 81.325 percent opacity
Downscale Response Value (0.05 x filter value) 4.280 percent opacity

Upscale	1	1.80	seconds
	2	2.00	seconds
	3	1.70	seconds
	4	2.10	seconds
	5	2.00	seconds
Downscale	1	2.80	seconds
	2	3.00	seconds
	3	2.90	seconds
	4	3.30	seconds
	5	3.10	seconds

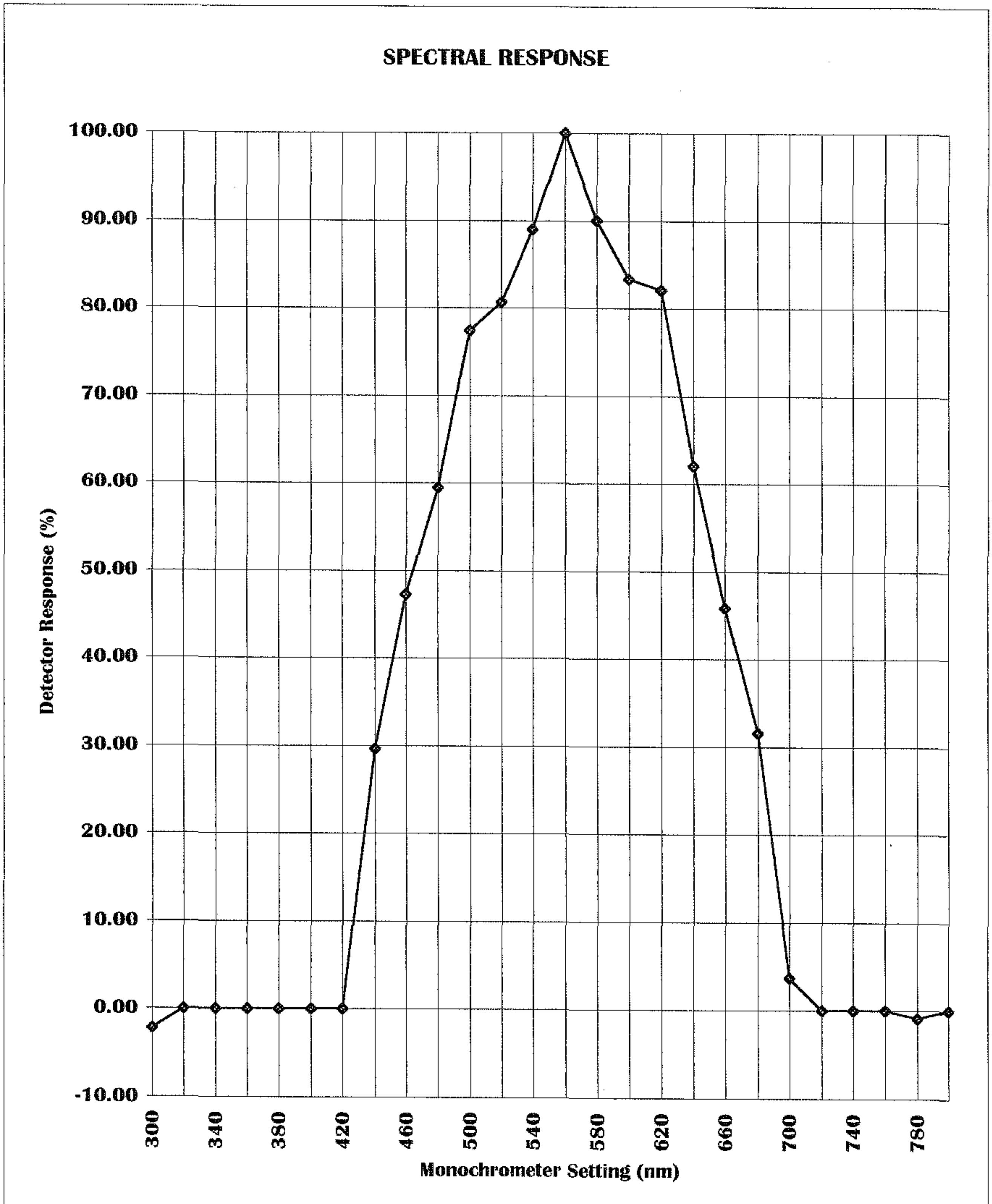
Average Response 2.47 seconds

IV. RESPONSE TIME TEST DATA SHEET

(*Enter "Upscale" and "Downscale" values.)

	Upscale	
1	1.80	seconds
2	2.00	seconds
3	1.70	seconds
4	2.10	seconds
5	2.00	seconds

	Downscale	
1	2.80	seconds
2	3.00	seconds
3	2.90	seconds
4	3.30	seconds
5	3.10	seconds


SPECTRAL RESPONSE
Detector Response (%)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
-10.00
300
340
380
420
460
500
540
580
620
660
700
740
780
Monochrometer Setting (nm)

SPECTRAL RESPONSE DATA SHEET

Serial No. LS541-0426 **Operator:** ERNEST RAY KILLIAN

Date: 10-Sep-96

Monochrometer Setting (nm)	Test Output	Dark Output	Output Diff	Multiplier	Corrected Diff	Relative Transmission	Spectral Response	Response, % of peak
300	8.00	8.80	-0.80	4.14	-3.31	-0.022	-6.52	-1.16
320	9.00	9.00	0.00	2.80	0.00	0.000	0.00	0.00
340	9.00	9.00	0.00	2.08	0.00	0.000	0.00	0.00
360	11.00	11.00	0.00	1.65	0.00	0.000	0.00	0.00
380	14.00	14.00	0.00	1.47	0.00	0.000	0.00	0.00
400	10.00	10.00	0.00	1.32	0.00	0.000	0.00	0.00
420	12.00	12.00	0.00	1.22	0.00	0.000	0.00	0.00
440	52.00	12.00	40.00	1.13	45.20	0.297	130.46	23.30
460	80.00	12.00	68.00	1.06	72.08	0.473	217.51	38.84
480	100.00	12.00	88.00	1.03	90.64	0.595	285.41	50.97
500	130.00	12.00	118.00	1.00	118.00	0.774	387.04	69.11
520	135.00	12.00	123.00	1.00	123.00	0.807	419.57	74.92
540	145.00	12.00	133.00	1.02	135.66	0.890	480.56	85.81
560	160.00	12.00	148.00	1.03	152.44	1.000	560.00	100.00
580	144.00	12.00	132.00	1.04	137.28	0.901	522.32	93.27
600	133.00	12.00	121.00	1.05	127.05	0.833	500.07	89.30
620	129.00	12.00	117.00	1.07	125.19	0.821	509.17	90.92
640	98.00	12.00	86.00	1.10	94.60	0.621	397.17	70.92
660	75.00	12.00	63.00	1.11	69.93	0.459	302.77	54.07
680	55.00	12.00	43.00	1.12	48.16	0.316	214.83	38.36
700	25.00	20.00	5.00	1.14	5.70	0.037	26.17	4.67
720	20.00	20.00	0.00	1.17	0.00	0.000	0.00	0.00
740	30.00	30.00	0.00	1.20	0.00	0.000	0.00	0.00
760	45.00	45.00	0.00	1.25	0.00	0.000	0.00	0.00
780	50.00	51.00	-1.00	1.30	-1.30	-0.009	-6.65	-1.19
800	100.00	100.00	0.00	1.33	0.00	0.000	0.00	0.00
					Totals:	8.792	4939.87	

Mean Response =	561.83	nm
Peak Response =	560.00	nm

Remarks:

(1) Corrected Diff = Output Diff x Multiplier

(2) Relative Transmission = Corrected Diff / Max Corrected Diff

(3) Spectral Response = Relative Transmission x Monochrometer Setting

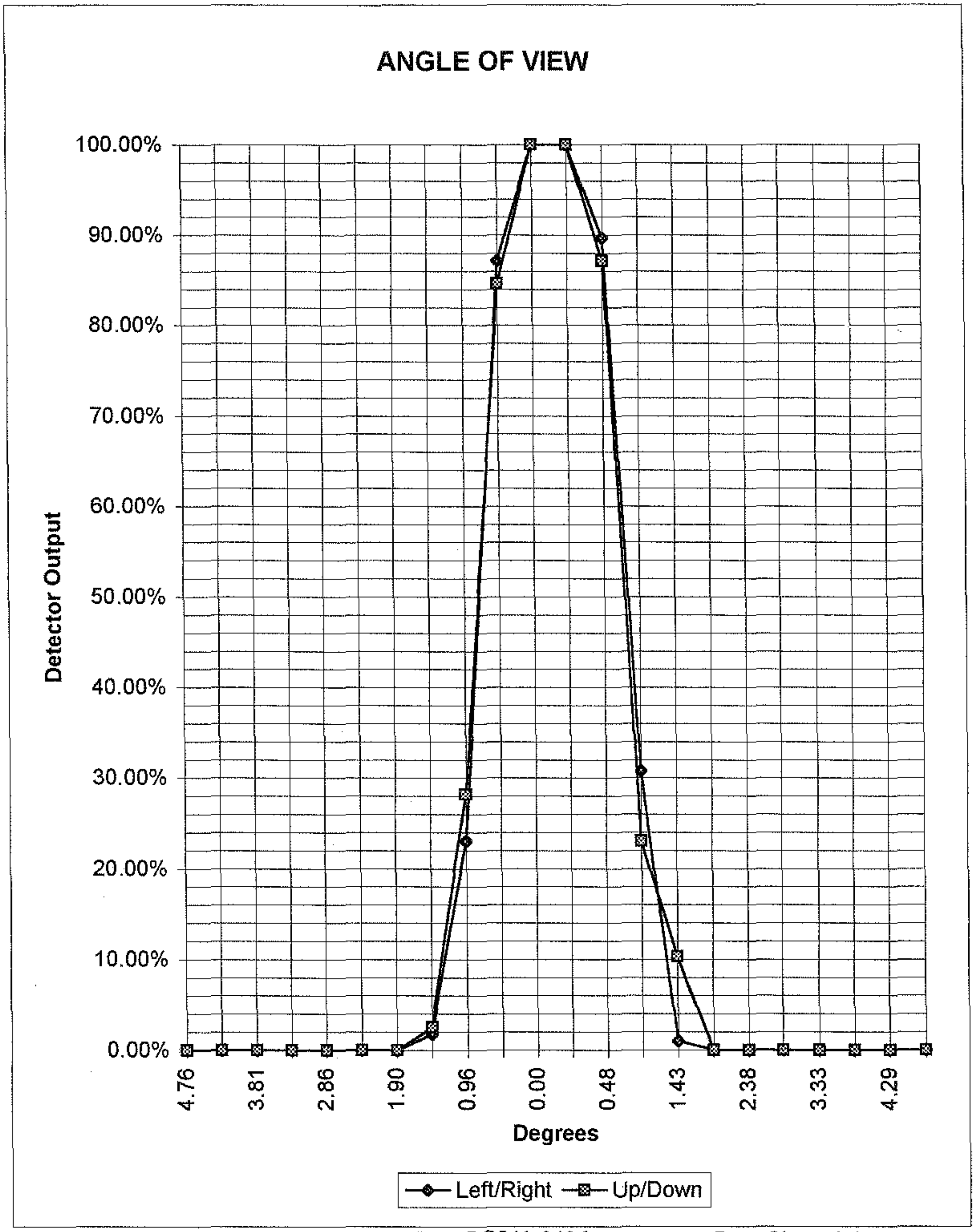
(4) Mean Response = Sum Spectral Response / Sum Relative Transmission

(5) Response, % of peak shaded values must be < 10 %.

V. SPECTRAL RESPONSE DATA SHEET

(*Enter "Test output" and "Dark Output.")

Monochrometer Setting (nm)	Test Output	Dark Output
300	8.00	8.80
320	9.00	9.00
340	9.00	9.00
360	11.00	11.00
380	14.00	14.00
400	10.00	10.00
420	12.00	12.00
440	52.00	12.00
460	80.00	12.00
480	100.00	12.00
500	130.00	12.00
520	135.00	12.00
540	145.00	12.00
560	160.00	12.00
580	144.00	12.00
600	133.00	12.00
620	129.00	12.00
640	98.00	12.00
660	75.00	12.00
680	55.00	12.00
700	25.00	20.00
720	20.00	20.00
740	30.00	30.00
760	45.00	45.00
780	50.00	51.00
800	100.00	100.00



S/N: LS541-0426 Data Sheet 1:1

AOV	**3.8 degrees**

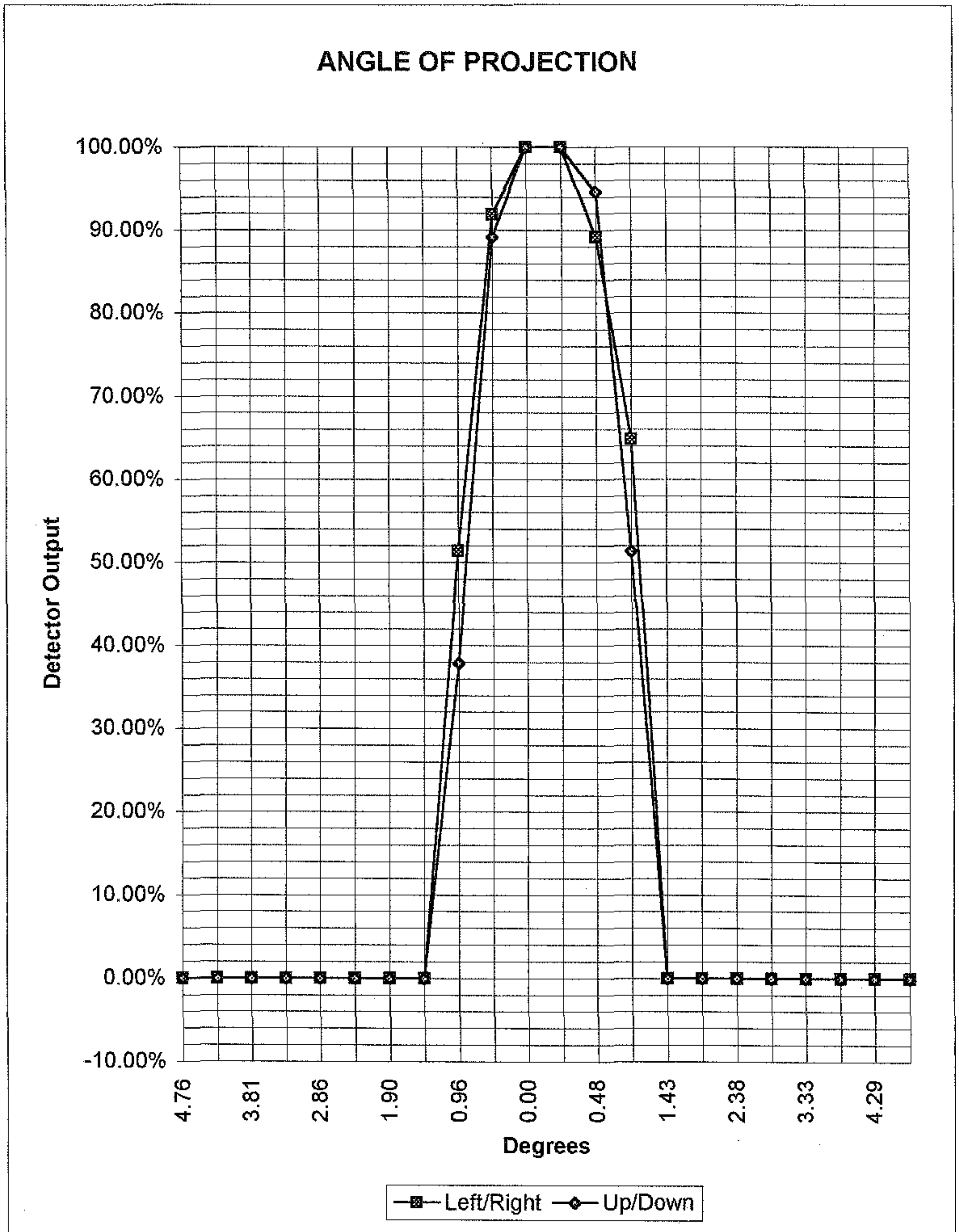
VI. ANGLE OF VIEW DATA SHEET

(*Enter Black Cloth, left, right, up, down data.)

Black Cloth (VOLTS) =

Dir CM	Left /Right (M.VOLTS)	Up/Down (M.VOLTS)	Degrees	Left/Right	Up/Down
0.0	40.000	40.000	0.000	100.00%	100.00%
2.5	35.000	34.000	0.480	87.18%	84.62%
5.0	10.000	12.000	0.960	23.08%	28.21%
7.5	1.700	2.000	1.430	1.79%	2.56%
10.0	1.000	1.000	1.900	0.00%	0.00%
12.5	1.000	1.000	2.380	0.00%	0.00%
15.0	1.000	1.000	2.860	0.00%	0.00%
17.5	1.000	1.000	3.330	0.00%	0.00%
20.0	1.000	1.000	3.810	0.00%	0.00%
22.5	1.000	1.000	4.290	0.00%	0.00%
25.0	1.000	1.000	4.760	0.00%	0.00%
22.5	1.000	1.000	4.290	0.00%	0.00%
20.0	1.000	1.000	3.810	0.00%	0.00%
17.5	1.000	1.000	3.330	0.00%	0.00%
15.0	1.000	1.000	2.860	0.00%	0.00%
12.5	1.000	1.000	2.380	0.00%	0.00%
10.0	1.000	1.000	1.900	0.00%	0.00%
7.5	1.400	5.000	1.430	1.03%	10.26%
5.0	13.000	10.000	0.960	30.77%	23.08%
2.5	36.000	35.000	0.480	89.74%	87.18%
0.0	40.000	40.000	0.000	100.00%	100.00%
Max=	40.000	40.000			
Min=	1.000	1.000			
Diff=	39.000	39.000			

Left	1.43 degrees
Right	1.43 degrees
Up	1.90 degrees
Down	1.90 degrees
Horizontal	2.86 degrees
Vertical	3.80 degrees
AOV	3.8 degrees



S/N: LS541-0426 Data Sheet 1:2

AOP	2.9 degrees

VI. ANGLE OF PROJECTION DATA SHEET

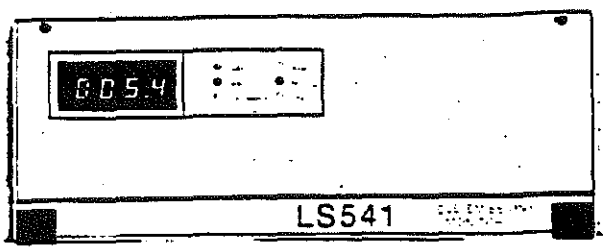
(*Enter Black Cloth, left, right, up, down data.)

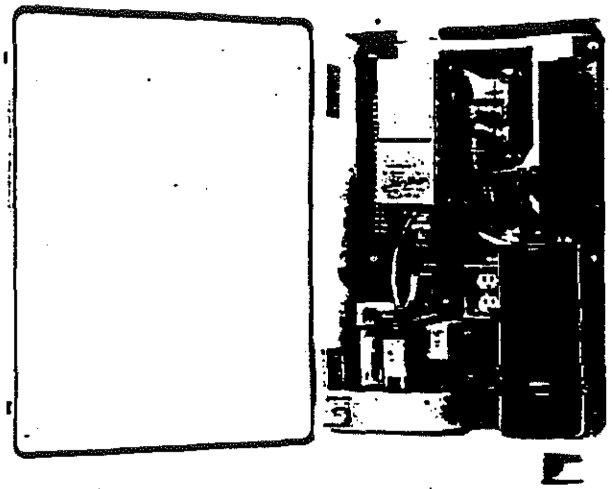
Black Cloth (VOLTS) =

Dir CM	Left /Right (M.VOLTS)	Up/Down (M.VOLTS)	Degrees	Left/Right	Up/Down
0.0	38.000	38.000	0.000	100.00%	100.00%
2.5	35.000	34.000	0.480	91.89%	89.19%
5.0	20.000	15.000	0.960	51.35%	37.84%
7.5	1.000	1.000	1.430	0.00%	0.00%
10.0	1.000	1.000	1.900	0.00%	0.00%
12.5	1.000	1.000	2.380	0.00%	0.00%
15.0	1.000	1.000	2.860	0.00%	0.00%
17.5	1.000	1.000	3.330	0.00%	0.00%
20.0	1.000	1.000	3.810	0.00%	0.00%
22.5	1.000	1.000	4.290	0.00%	0.00%
25.0	1.000	1.000	4.760	0.00%	0.00%
22.5	1.000	1.000	4.290	0.00%	0.00%
20.0	1.000	1.000	3.810	0.00%	0.00%
17.5	1.000	1.000	3.330	0.00%	0.00%
15.0	1.000	1.000	2.860	0.00%	0.00%
12.5	1.000	1.000	2.380	0.00%	0.00%
10.0	1.000	1.000	1.900	0.00%	0.00%
7.5	1.000	1.000	1.430	0.00%	0.00%
5.0	25.000	20.000	0.960	64.86%	51.35%
2.5	34.000	36.000	0.480	89.19%	94.59%
0.0	38.000	38.000	0.000	100.00%	100.00%
Max=	38.000	38.000			
Min=	1.000	1.000			
Diff=	37.000	37.000			

Left	1.43 degrees
Right	1.43 degrees
Up	1.43 degrees
Down	1.43 degrees
Horizontal	2.86 degrees
Vertical	2.86 degrees
AOP	2.9 degrees

LS541 OPACITY MONITOR





INSTRUMENT OVERVIEW

The LS541 is a rugged precision instrument that measures visible emissions or opacity. It was designed to accommodate current and future EPA regulatory requirements and is based on our experience with over 5000 successful installations. It incorporates state-of-the-art measurement capabilities and provides new and unique performance data in both serial and analog formats. The complete measurement system is designed for the hostile industrial environment and requires very little maintenance.

The LS541 provides opacity measurements corrected to stack exit conditions with two separate opacity alarms. A microprocessor provides extensive self-diagnostics that simplify setup, operation and maintenance of the instrument. The LS541 can be used in other applications to monitor particulate density or optical density in a flue gas.

The LS541 calibration cycle provides an automatic check of the complete electro-optic system. This calibration cycle determines and corrects for zero/span drift and window dirt/zero compensation.

The LS541 allows for a variety of measurements that are available in 4-20mA analog form (opacity, transmittance, optical density, and particulate density). The RS232/422 serial digital output is easily configured for connection to a DAS or serial printer.

FEATURES

ACCURACY—The zero and span calibration check mechanism provides an exact simulation of a clear stack condition and a known upscale measurement. It corrects itself for zero and span drift as well as for window dirt accumulation. The unit incorporates an extremely rugged signal processing system that eliminates the effects of noise, lamp intensity variations, and changes in ambient light.

FLEXIBILITY—Three measurement outputs are configurable for either opacity, transmittance, optical density, or particulate density and are corrected to stack exit conditions. Each output can be independently ranged for the application.

RS232/422 SERIAL/DIGITAL OUTPUT—The output provides a complete record of the calibration performance parameters and measurement values along with a time/date stamp. A complete listing of all configuration parameters can be output on demand to verify instrument setup.

RELIABILITY—The transceiver and reflector units contain no continuously moving parts. The zero calibration reflector and transceiver/reflector optics are protected from the stack gases by an air-purge system. As a backup, the transceiver and reflector optics are also protected by a removable and replaceable BK-7 glass slide assembly. The span filter is contained within the sealed transceiver housing and is never exposed to stack gases.

REFERENCE METHOD COMPATIBILITY—The full photopic spectral response duplicates the response of a light adapted human eye. As a result, the measurements compare with visual smoke measurements (40CFR60, App. A, Ref. Meth. 9) and are valid with all types of audit filters.

COMPLETE STATUS INFORMATION—Zero and span drift are internally computed with maintenance alarm at 2% limit and out-of-control fault at 4% limit. The LS541 also provides both an analog and digital record of the occurrence and clearing of all alarm and fault conditions.

COMPLIES WITH PENDING REGULATORY REVISIONS—The LS541 provides the capability to track and record changes in the optical path length ratio in both analog and digital format. It also allows for the recording of bipolar drift with an expanded scale on conventional chart recorders.

LS541 SPECIFICATIONS

The LS541 meets or exceeds U.S. EPA design and performance requirements as specified in 40 CFR 60. Appendix B. Performance Specification 1.

PERFORMANCE SPECIFICATIONS
Opacity measurements are provided within the following specifications. based on equivalent single-pass response:
Zero Drift: Less than 1%
Calibration Drift: Less than 1%
Calibration Error/Accuracy: ±2%
Response Time: Less than 5 seconds
Analog Output Resolution: 0.5% of full scale
Serial Digital Output Resolution: 0.1% opacity

OPERATING TEMPERATURE
Transceiver Ambient: −20°C to +54°C (−20°F to +130°F)
Control Unit Ambient: +5°C to +43°C (+40°F to +110°F)
Process Gas: Up to 399°C (750°F) standard: consult factory for higher temperature configuration.

OPTICAL SYSTEM
Double-pass. dual beam system employing ratiometric measurement technique. Visible light optical projection and detection system with solid-state/electronic light modulation system. No continuously moving components in transceiver.
Lamp: Incandescent lamp in prealigned base. expected life 30,000 hours.
Spectral Response: Approximately photopic. with peak and mean response between 500 nm and 600 nm. and less than 10% of peak response outside the desired 400 nm to 700 nm region comprising the visible light spectra.
Bandwidth: Within ±20% of photopic. or between 80 and 120 nm as measured at the 50% response points.
Optical Divergence: Light source angle of projection is less than ±2° from optical axis: photodetector angle of view is less than ±2° from optical axis.
Alignment: Observed visually by activating the alignment solenoid that displays the received beam on an alignment target in the transceiver. A misalignment corresponding to a 2% change in opacity is visible. An integrated retroreflector alignment system is available on certain models.

MEASUREMENT SYSTEM
Calibration: Calibration can be activated automatically at selectable hourly intervals (0-99). or manually from either the stack or control unit. The calibration mechanism provides a complete check of the system electro-optics. utilizes zero calibration reflector and glass-span filter.
Time/Date: Internal clock and calendar with battery backup provide continuous accumulation of time and date.
Measurement Averages: Selectable fast averages of 0-99 seconds. and selectable slow averages of 0-99 minutes.
Opacity Alarms: Two. independently settable high and early warning alarms.
Calibration Drift Alarms: Warning at 2% opacity. fault at 4% opacity.
Window Dirt/Compensation Alarm: 4% opacity.
OPLR Change Indication: The system maintains two independent values of the OPLR. the original OPLR (burned into PROM) and the current/working OPLR (operator accessible via password). Both values are output in the Auxiliary Performance Parameters output data stream. and in the serial RS232/422 output.
Analog Output Selection: Opacity corrected to stack exit conditions. transmittance. optical density. particulate density. and auxiliary performance parameters.
Serial Data Output Selection: Opacity exceedances. fast averages. or slow averages with complete calibration data including OPLR. drift measurements. window dirt/compensation. alarms and warnings—all with time/date stamp. On demand listing of configuration and operating variables.

PHYSICAL
Control Unit: (h x w x d): 10.2 x 6.9 x 19 in. (17.4 x 48.3 x 25.4 cm)
Weather Covers: (h x w x d): 30 x 22.5 x 23 in. (76.2 x 57.2 x 58.4 cm): approximately 45.4 kg (100 lb.) per side including weather cover. air-purge blower. and transmissometer
Reflector: Standard retroreflector assemblies are available for flange to flange separation distances from 3 to 40 feet. Consult factory for other distances.
Air-Purge System: Two blowers per system. one each for the transceiver and the retroreflector: three-stage air filtration and air purge failure detection. Air-Purge flows: 10 SCFM at 33" H_2O (78 cm_3/min at 840 mm) at 60Hz: 10 SCFM at 25" H_2O (78 cm_c/min at 630 mm) at 50Hz.

UTILITY REQUIREMENTS
Control Unit: 115Vac ±10%. 50/60Hz. 1Ø. 1A: 230Vac ±10%. 50Hz. 1Ø. 0.5A.
Air-Purge Blowers: 115Vac ±10%. 50/60Hz. 1Ø. 3.5 FLA. 10.6 LRA: 230Vac ±10%. 50/60Hz. 1Ø. 1.7 FLA. 5.3 LRA (current requirements per blower).
Transceiver/Stack Interface Assy: 115/230Vac ±10%. 1Ø. 50/60Hz. 1A.

CONSTRUCTION
Transceiver/Reflector: NEMA 4 cast aluminum transceiver housing with removable access covers chained to housing and welded steel reflector assembly.
Weather Covers: Corrosion resistant fiberglass weather-tight cover with integral heat shield/mounting plate: hinged side-opening cover with gasket provides full access to all equipment and wiring.
Control Unit: 19 inch rack or panel-mount. Front panel hinges down for full access to manual controls and electronics. Rear panel mounted wiring terminals.

INSTALLATION INTERFACES
Weather Covers: Mounts to customer-supplied 6 in. (15.2 cm) 150# flanges: typical 6 in. (15.2 cm) long. Schedule 40 pipe. Adapters available for other flanges.
Cable: Stack to control unit. six overall shielded. twisted shielded pairs. 18 AWG (minimum).

OUTPUTS
Analog Outputs: Three linear 4-20mA outputs. individually programmed. Outputs can be scaled for stack-exit opacity from 0% to 100% in 1% increments: light transmission from 0% to 100% in 1% increments: optical density from 0.0 to 1.00 in 0.001 increments: particulate density from 50 to 9999 mg/m^3 in 50 mg/m^3 increments.
Digital Outputs: RS232 or RS422 (DB9F connector) is available. ROM-based communication software transmits data in datalogger format to interface with a DAS or a serial printer. Baud rate (9600. 4800. 2400. 1200). parity (odd. even. mark. none). and hardware handshake signals are programmable.
Contacts: Four single pole. single throw (SPST). 115Vac. 5 amp contact closures for early warning. alarm. calibration. and general instrument fault. Contacts can be modified for NO or NC operation.

MADE IN THE U.S.A.

Monitor Labs. Inc. (formerly Lear Siegler Measurement Controls Corporation) reserves the right to make changes in construction. design. specifications. and/or prices without prior notice.

MONITOR LABS, INC.
formerly
Lear Siegler Measurement Controls Corporation
74 Inverness Drive East
Englewood, CO 80112-5189
(303) 792-3300 • Fax (303) 799-4853

82-415
82-410

INSTRUCTION MANUAL

Part Number: 004149

MONITOR LABS, INC.
formerly
Lear Siegler Measurement Controls Corporation
74 Inverness Drive East
Englewood, CO 80112-5189
(303) 792-3300 • Fax (303) 799-4853

Warranty

All Jarrell-Ash products are guaranteed against defective parts or workmanship for one year, except for electronic components which carry the guarantee of their manufacturer. In keeping with a policy of continued research and improvement, the Jarrell-Ash Division reserves the right to alter specifications and to supply equipment differing from that described. Defective items will be replaced free of charge, transportation charges to be borne by the customer.

DAMAGE IN SHIPMENT

IT IS THE RESPONSIBILITY OF THE BUYER TO INITIATE ANY CLAIMS FOR SHIPPING DAMAGE.

On all shipments the customer is responsible for reporting any damage in shipment to the carrier and for arranging inspection of any damaged parts. In the case of shipment F. O. B. Waltham, the customer is responsible for filing any damage claims with the carrier.

Although Jarrell-Ash instruments are sturdily constructed, they can be damaged through severe handling in shipment. The Jarrell-Ash Division cannot make any adjustment for such damage and will charge for any repairs and/or parts necessary.

Carefully examine the crate for superficial evidence of rough treatment. Even if such evidence is not apparent, do not waive claim for damage, since hidden damage can often be revealed only by close inspection of the assembled instrument. Reimbursement from the carrier will be facilitated, if the preceding recommendations are followed.

REPAIRS

The entire instrument has been constructed of rugged components selected for long life provided reasonable care is shown. If any major parts need repair or replacement, contact the nearest Jarrell-Ash Division representative or the factory for advice.

Investigation of failures, and repair of electronic components should be performed only by qualified personnel.

RETURN OF GOODS

Jarrell-Ash sales policies do not permit goods to be returned to the factory for credit, repair, restocking or replacement under existing warranties including goods damaged in transit, without prior authorization. Indicate serial number of any instrument being returned.

CONTRACT DATA

Manufacturer's Model Number ____________________

Manufacturer's Serial Number ____________________

Customer's Contract Number ____________________

TABLE OF CONTENTS

SECTION 1 INTRODUCTION

1–1 General Description

All Jarrell-Ash 82-410 Quarter-Meter Monochromators are now provided with one 1180 g/mm, 66.0 mμ blaze grating and one 2360 g/mm, 300.0 mμ blaze grating. Use of the 2360 g/mm grating effectively eliminates the problems of re-entry spectra and high stray light in the 300.0 mμ region. The gratings can be interchanged simply by "flipping" an external control knob. Two separate wavelength counters are provided for maximum convenience. Additionally, the added dispersion provided by the 2360 g/mm grating permits higher resolving powers to be obtained over the 200.0 to 500.0 mμ range.

The 82-410 monochromator may be used as a monochromatic illuminator or as a spectrometer in a wide variety of applications, including measurements of: absorption, transmission, emission, reflection, radiation, fluorescence, phosphorescence and low level luminescence of all types. It is useful as a source of monochromatic light for microscopes, photometers, and other spectrometric uses. The versatility of the Model 82-410 Series Monochromator makes it the standard monochromator for general use in physics, chemistry, biology laboratories. The instrument is suitable for use in the ultraviolet, visible and infared.

This manual should be read and understood thoroughly prior to commencing installation, operation, and/or servicing.

1–2 Equipment Specifications

Overall dimensions:	17.7 x 22.1 x 21.4 cm 7" x 8-3/4" x 12-1/2"
Weight:	Approximately 12 lbs.
Focal Length:	0.25 meter
Linear Dispersion:	3.3 mμ/mm with 1180 grooves/mm grating 1.65 mμ/mm with 2360 grooves/mm grating
Aperture Ratio (Speed): Model 82-410	f/3.5
Gratings (two Supplied):	Ruled Area 64mm x 64mm Replicas, 1180 grooves/mm; 2360 grooves/mm
Gratings Blazed at:	300.0 mμ and 500.0 mμ
Resolution: (half-band width at 313.1 mμ)	Better than 3A resolution at 3131 A (Order I, with 60,000 LIP grating or 3131 Order II with 30,000 LIP) with 150 μ slits.
Scattered Light:	Less than 0.2% measured over a range of 2000 A to 4000 A, using a Tungsten or Hydrogen source with a 1P28 PM tube detector.
Slits:	Two 150 micron slits, standard interchangeable.
Slit Arrangement:	Focusing slits in line on opposite sides of instrument
Calibrated Readouts:	Preadjusted and calibrated, three digit wavelength dials read directly in millimicrons, 0-900 equivalent to 0 to 900 mμ, accuracy ±1 mμ.
Wavelength Drive Coverage:	0 to 900 mμ.

1–3 Component Identification and Description

1-3-1 OVERALL VIEW 82-410 (Figure 1)

1. Interchangeable Slit

   150μ, standard width, others available.

2. Slit Focus

   A #6-32 x 3/4" long oval tip set screw is provided in the right hand threaded hole in the slit face plate, and is used to set focus.

3. Two nylon tipped set screws are used to retain the focus tube position.

4. Wavelength Drive Knob

   Hand rotated to cover 0-999.0 mμ.

5. Mounting holes for electric drive accessories.

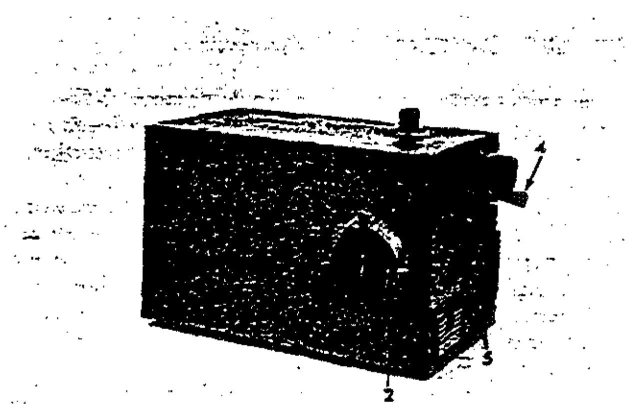


Figure 1

45-542-A-01	Tungsten Lamp for 45-541
45-543	Xenon Lamp and power supply. For 115 volts, 60 cycles, single phase.
45-543-A-01	Xenon Lamp
45-544	Mercury Lamp & Power Supply. For 115 volts, 50/60 cycles, single phase.
45-544-A-01	Mercury Lamp. For 115 volts, 50/60 cycles, single phase.
45-544-A-01	Mercury Lamp.

1-4-2 MOUNTING AND SCANNING ACCESSORIES

Catalog Number	
82-414	Spectral Viewer, including illuminated reticle.
82-451	Gear Assembly for wavelength drive.
82-452	Motor unit for 10 mμ/min. For 115 volts, 60 cycles, single phase.
82-453	Motor unit for 10 mμ/min. For 115 volts, 50 cycles, single phase.
82-455	Motor unit for 25 mμ/min. For 115 volts, 60 cycles, single phase.
82-454	Motor unit for 25 mμ/min. For 115 volts, 50 cycles, single phase.
82-457	Motor unit for 100 mμ/min. For 115 volts, 60 cycles, single phase.
82-456	Motor unit for 100 mμ/min. For 115 volts, 50 cycles, single phase.
82-442	Adaptor for Jarrell-Ash Accessory Bars of 10-000 series.

Catalog Number	
10-014	Jarrell-Ash 100 cm bar.
10-024	Jarrell-Ash 125 cm bar.
10-034	Jarrell-Ash 150 cm bar.
82-443	Adaptor for triangular profile optical bar.
10-104	Triangular profile, 50 cm optical bench.
10-114	Triangular profile, 100 cm optical bench.

1-4-3 GRATINGS AND HOLDERS

Catalog Number	
11-043	Holder for two gratings of 69 x 69 x 6 mm blank size. (Holder readily interchanged with one supplied with instrument.)
11-044	Holder for one grating of 69 x 69 x 10 mm blank size.
985-30-20-18	Grating, 1180 grooves/mm, blazed for 3000 A.
985-30-20-24	Grating, 1180 grooves/mm, blazed for 6000 A.
985-30-30-30	Grating, 590 grooves/mm, blazed for 1.2 microns.
985-30-30-36	Grating, 295 grooves/mm, blazed for 2.1 microns.
985-30-69-50	Grating 50 grooves/mm, blazed for 10.0 microns.
985-30-10-17	Grating, 2365 grooves/mm, blazed for 3000 A.

1-4-4 SLITS

12-510	Slit width 25 microns.
12-515	Slit width 50 microns.
12-525	Slit width 100 microns.
12-535	Slit width 250 microns.
12-540	Slit width 500 microns.
12-560	Slit width 1000 microns.
12-570	Slit width 2000 microns.
12-590	Circular aperture, 3mm dia.
12-591	Circular aperture, 6mm dia.

1-4-5 POWER SUPPLIES AND AMPLIFIERS

Catalog Number	
26-780	Power Supply Amplifier for DC operation. For 110 volts, 60 cycles.

1-4-6 PHOTOMULTIPLIERS

83-021	Side Window Photomultiplier Tube Housing with wired socket.

SECTION 2 PRE-OPERATIONAL CHECK

2–1 Unpacking

The 82-410 should be carefully unpacked and inspected for any visible signs of damage. The customer is responsible for filing any damage claim against the carrier. All items should be checked against the packing list so that no small parts will be discarded with the packing material.

2–2 Installation

The 82-410 is shipped completely assembled, adjusted, and calibrated. However, the grating yoke is locked in place by a red screw, which must be removed before operating the instrument.

2-2-1 Remove the main compartment cover plate.

2-2-2 Remove the Red, grating yoke shipping screw. Follow the directions on the blue card attached to the main compartment cover plate.

2-2-3 Replace the cover plate.

Note The shipping screw should be retained and replaced, whenever the instrument is to be transported to a new location.

2–3 Optical Alignment Procedure

The 82-410 has been completely aligned and calibrated at the factory, and NO further adjustments should be required. However, to insure that no damage has occured during shipment, or that the alignment has not been disturbed, a visual check of the alignment should be made. The complete alignment procedure is outlined in the following steps, and should be followed closely to insure proper operation.

2-3-1 Remove main compartment cover plate.

2-3-2 Set a bright tungsten source at the entrance slit (150 μ). The light beam reflected from the 45° mirror (B, Fig. 3) should be centered on the rear collimating mirror (C-1, Fig. 3), which is closest to the entrance slit.

2-3-3 Then remove the tungsten source to the exit slit (150 μ). The light beam reflected from the 45° mirror (E, Fig. 3) should be centered on the rear collimating mirror (C-2, Fig. 3) which is closest to the exit slit.

Note Do not adjust the 45° mirrors before checking the rest of the alignment.

2-3-4 Remove the tungsten source from the exit slit and place a mercury lamp at the entrance slit (150 μ).

2-3-5 Rotate the grating selector knob to the 1180 g/mm grating (High) position.

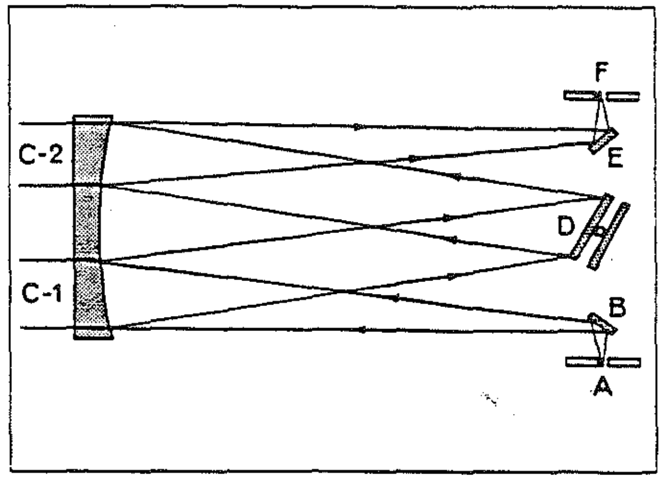


Figure 3

2-3-6 Rotate the wavelength drive until a bright blue mercury line is seen visibly through the 150 μ exit slit. Set the counter at 871.5 mu, by loosening the set screw on the small counter gear (2, Fig. 4).

2-3-7 Rotate the grating selector arm until the 2360 g/mm grating adjusting screw contacts the magnetic stop. A blue mercury line should be visible at the exit slit.

Note Extreme care must be taken to prevent any contact of the grating face, or mirror surfaces - Permanent damage will result.

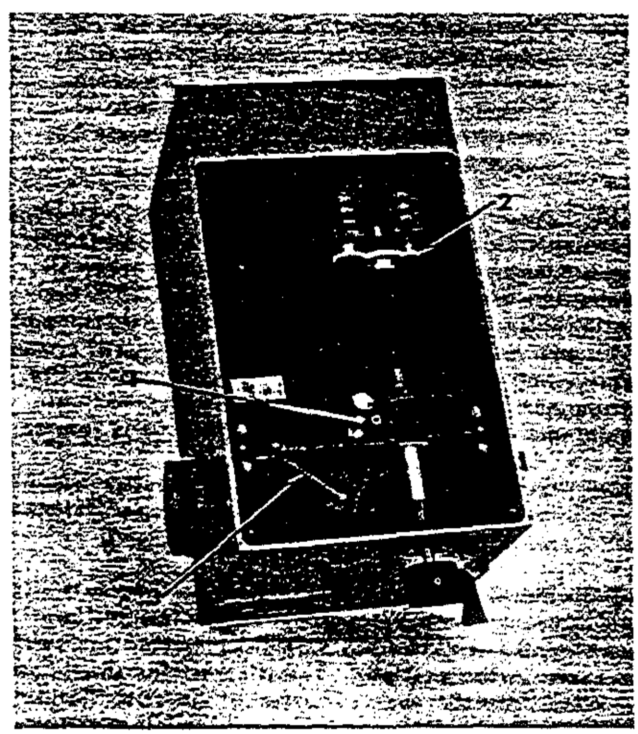


Figure 4

All readings should be taken rotating the wavelength drive in the same direction, to eliminate errors due to backlash.

2-4-5 If the counter readings obtained, for the various mercury lines, exceed the true wavelength values by more than ±1 mμ, the wavelength drive will require some adjustment.

2-4-6 By plotting the wavelength calibration on a graph as shown in Fig. 7; one is easily able to determine which adjustment is required to properly calibrate the wavelength drive.

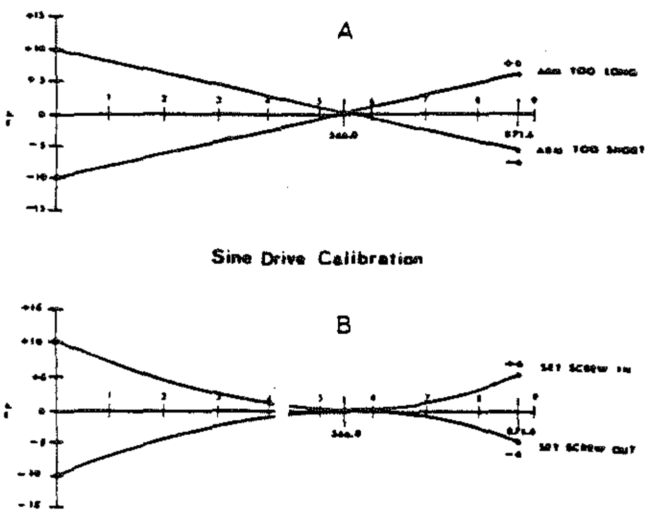


Figure 7

2-4-7 If the plot shows the error to be a curved line bending up, as shown in Fig. 7B; the set screw (7, Fig. 5) should be adjusted (1/2 turn or less) counter clockwise. The set screw (7, Fig. 5) is adjusted clockwise if the curve bends down.

2-4-8 If the plot shows the error to be a straight line going up as shown in Fig. 7A; the length of the arm (8, Fig. 5) must be shortened. Loosen cap screw (5, Fig. 5) and adjust cap screw (6, Fig. 5) counter clockwise (1/2 turn or less). Push the arm toward the pivot and tighten cap screw (5, Fig. 5). The arm (8, Fig. 5) is made longer if the plot shows the error to be a straight line going down.

Note All adjustments should be kept small. Adjustments of 1/2 turn or less on all adjusting screws are adequate.

2-4-9 Repeat Steps 2-4-2 through 2-4-8 until the calibration is complete. Calibration is complete when all readings are within ±1 mμ.

2-4-10 The second grating requires only to be zeroed out at 546.0 mμ. Refer to Para.'s 2-3-5, 2-3-6, 2-3-7, and 2-3-8. All points should then be identical to those of the first grating.

2–5 Use of Gratings Other than 1180 groove/mm

1. All Jarrell-Ash Model 82-410 monochromators are provided with wavelength counters calibrated for 1180 groove/mm. To obtain direct wavelength readings for other gratings, use the following table:

Grating Spacing	For Counter Reading Multiply Desired Wavelength by Factor	OR	For Wavelength Multiply Counter Reading by Factor
2360 g/mm	1.0		1.0
1180 g/mm	1.0		1.0
590 g/mm	0.5		2.0
295 g/mm	0.25		4.0
2160 g/mm	1.83		0.5468

Note At 546.0 mμ when using a 590 g/mm grating a green line will be seen at the exit slit. This line is the 2nd order of 546.0 mμ. A 295 g/mm grating will show the 4th order green at a setting of 546.0 mμ. The order of the line will be the same as the factor (described above) at any particular setting.

2–6 Interchanging Grating Holders

Additional gratings may be mounted in separate holders (two per holder). Grating holders may easily be interchanged in the 82-410 by following the procedure listed below.

CAUTION Extreme care must be taken to prevent any contact with face of grating. This will result in permanent damage.

2-6-1 Remove the monochromators main compartment cover plate.

2-6-2 Unscrew the grating selector arm (1, Fig. 4).

2-6-3 Disconnect spring (3, Fig. 4) from grating yoke.

2-6-4 Lift entire grating yoke assembly (Fig. 5) until the bottom pivot is free of the pivot boss, move the bottom of the grating yoke to the rear of the instrument until free of all obstacles before lifting it out of the monochromator.

2-6-5 To remove the grating and holder from the yoke, grasp the dual holder firmly at the sides and push against the spring loaded pivot (9, Fig. 5) at the top of the yoke. Swing the bottom of the holder out and free of obstructions and remove from yoke. Replace a new grating and holder in the same manner. Care should be taken to ensure that grating holder will rotate freely within the grating yoke.

2-6-6 Carefully replace grating yoke assembly within the monochromator and complete the assembly by replacing the spring (4, Fig. 4) and the selector arm (1, Fig. 4).

SECTION 3 OPERATION

3–1 Manual Wavelength Drive

1. Turn the wavelength drive knob to the region of interest i.e., 250 mμ = 2500 Å.

2. Select the most efficient grating for the area of interest by use of the grating selector. Note that the selector knob will turn 180° only. Do not force this selector knob.

3. Illuminate the entrance slit with the desired source.

4. Install the desired phototube or detector at the exit slit.

3–2 Electrical Wavelength Drive

1. By use of an accessory kit, the unit can be converted for electrical scanning with a choice of drive rates: 10 mu/min. - Catalog No. 82-452; 25 mu/min. - Catalog No. 82-455; 100 mu/min. Catalog No. 82-457. Each of these units contains a motor on a mounting plate, complete with drive gear, line cord, switch, and plug.

2. Remove the crank knob on the wavelength drive shaft and attach the drive gear (Cat. No. 82-451) on the shaft. Replace handle. Insert knurled screws into appropriate threaded holes (3, Fig. 1). Do not screw these all the way home.

3. The keyhole slots of the motor mounting bracket fit over the knurled screw heads. Slide motor vertically upwards for full engagement into driven gear and tighten knurled headed screws.

4. Connect line cord to a 110 V, 60 cycle outlet.

5. The electrical drive is arranged to scan in a direction of increasing wavelength only. When the electrical drive is in operation, the manual drive may not be used.

6. To return to starting wavelength, switch OFF motor, manually rotate wavelength drive to a shorter wavelength region then switch ON the motor drive to scan to higher wavelengths.

7. The motor is provided with a stall clutch mechanism. If the high wavelength limit of travel is reached, the motor will stall but the switch will remain ON. It is important, to switch OFF the motor before returning the wavelength drive to a shorter wavelength setting.

8. For a change of wavelength drive speed, exchange one motor drive unit for another. To do this, remove line cord from the electrical outlet, loosen the knurled headed screws and remove the motor drive unit by use of the keyhole slots. Replace the drive unit of the desired speed and engage the electric drive gear with the shaft gear, then tighten the knurled screws.

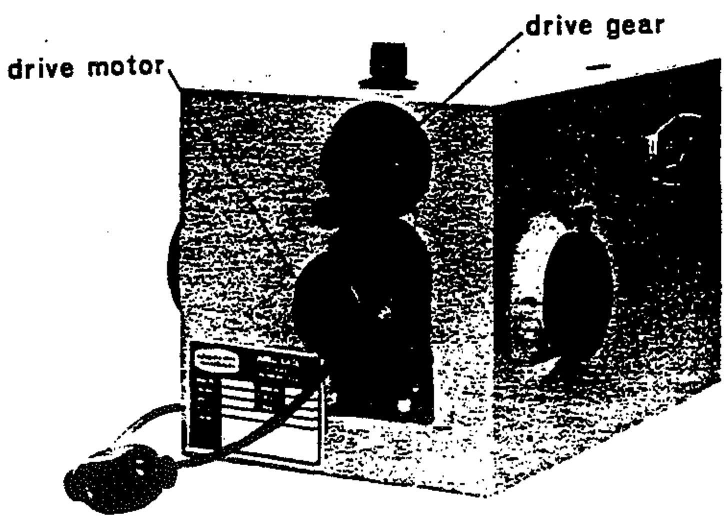


Figure 8

[redacted]

Thermo Jarrell Ash Corporation

8E Forge Parkway
Post Office Box 9101
Franklin, MA 02038-9101

(508) 520-1880
Fax (508) 520-1732
Telex: 174230 TJA UT

February 19, 1991

Mr. Joe Golaszewski
Lear Siegler
74 Inverness Drive East
Englewood, Colorado 80112

Dear Mr. Golaszewski:

In reference to your question on the use of a HeNe laser to align a Jarrell Ash 0.25 meter monochromator, this is an acceptable method of alignment. Remember that the original Hg lamp method used when the instrument was first designed was the only available method, lasers were not commercially available in the 1950's.

In recent years the use of HeNe lasers for alignment has become more prevalent, and I believe will ultimately replace the Hg lamp method. Our largest customer of OEM spectrographs (0.275 meter models) uses the HeNe laser method exclusively.

Please do not hesitate to contact us with questions on this or any matter pertaining to the 0.25 meter monochromator.

Regards,

Irene T. Galiher
Thermo Jarrell Ash

IN-HOUSE NEUTRAL DENSITY FILTER CALIBRATION

1.0 SCOPE

THIS PROCEDURE DEFINES THE METHOD FOR MAINTAINING THE CALIBRATION OF ALL NEUTRAL DENSITY FILTERS USED TO TEST, VERIFY OR CERTIFY ALL OPACITY MONITORS MANUFACTURED AT LSMCC.

2.0 APPLICABILITY

THIS PROCEDURE APPLIES TO THE QUALITY CONTROL DEPARTMENT ASSOCIATES AND ALL COMPANY PERSONAL WHO UTILIZE THESE FILTERS, EITHER FOR IN-HOUSE OR FIELD USE.

3.0 RELATED DOCUMENTS

* CFR 40 PT. 60 PERFORMANCE SPECIFICATION 1
* MIL-STD-45662A CALIBRATION SYSTEMS REQUIREMENTS
* BECKMAN DU SERIES 7000 MANUAL

4.0 EQUIPMENT AND FACILITIES

* NIST GLASS FILTERS, SRM 930D (3), SET NUMBERS 10-1626, 20-1626 AND 30-1626.
* BECKMAN DU 7500 DIODE ARRAY SPECTROPHOTOMETER, S/N 4300139 (SEE PAGE 4).

5.0 RESPONSIBILITY

THE QUALITY CONTROL MANAGER AND ASSOCIATES, IN CONJUNCTION WITH THE TECHNICAL SERVICE DEPARTMENT, SHALL FORM A PARTNERSHIP TO INSURE COMPLIANCE WITH THIS PROCEDURE.

6.0 BASIC OPERATING PROCEDURE

6.1 ALL FILTER CALIBRATIONS PERFORMED BY THE QUALITY CONTROL DEPARTMENT WILL BE TRACEABLE TO THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST). THESE STANDARDS WILL BE USED TO VERIFY THE ACCURACY OF THE CALIBRATION SPECTROPHOTOMETER PRIOR TO EACH QUARTERLY FILTER CALIBRATION OR RANDOM QUALITY AUDITS.

6.2 THE QUALITY CONTROL DEPARTMENT WILL MAINTAIN A COMPUTERIZED SYSTEM FOR THE TRACKING OF ALL FILTER CALIBRATION ACTIVITY. THESE FILTERS WILL BE CALIBRATED ON A QUARTERLY BASIS IN COMPLIANCE TO CFR 40, PT. 60, PERFORMANCE SPECIFICATION 1.

7.0 TEST PROCEDURE

7.1 SPECTROPHOTOMETER VERIFICATION

7.1.1 EXECUTE THE PERFORMANCE VALIDATION TESTS AS OUTLINED IN SECTION 20 OF THE BECKMAN MANUAL.

8.2 FILTER CALIBRATION HISTORY (continued)

AFTER EACH QUARTERLY CALIBRATION. THIS REPORT WILL OUTLINE THE SERIAL NUMBERS, NEW VALUES GIVEN, FILTER DRIFT AND ANY FILTERS BEING ADDED OR REMOVED FROM THE SYSTEM.

Table One

Beckman DU 7500 Verification

Performance Validation HELP

RunTests StopTests CalibrateWavelength Print Quit

Warning: Unblock the Beam

Instrument number: 4300139

Absorbance Noise test at 340nm

First reading = -0.000094A

S1 = 0.000070
S2 = 0.000038
S3 = 0.000059
S4 = 0.000059
S5 = 0.000069
S6 = 0.000086
S7 = 0.000060
S8 = 0.000055
S9 = 0.000077
S10 = 0.000051

Average SD = 0.000063

Wavelength Tests

Accuracy

Nominal	Actual	Difference
486.00	487.23	1.23

Repeatability

Nominal	Actual	Difference
487.23	487.23	0.00

Resolution Test

Resolution: 1.8547nm

Baseline Flatness Test

RMS Flatness: 0.0001

Stability Test

Wavelength = 340nm

Period	Delta Abs	Last Abs	Syx

BLANK	[VIS ON] RediScan	STATUS		TIME	DATE	TEMP	CELL
MATCH OFF	[UV ON] RediRead	DEVICES	PrtScrn	07:55	10/01/96	N/A	N/A

Table Two

Beckman DU 7500 Calibration

Single Component Analysis: Standards HELP

Samples DispStdCurve ViewStats DispScans Method SaveClear Print Quit

Standards file: A:\WORK_STD
Component name: 1626_10,20,30
Units: %T
Curve fit: Linear, zero intercept
Sampling device: None
Number of standards: 4
Read average time: 0.50 sec

Method name: A:\440_NIST ↓ ↑
Analytical wl: 440.0 nm
Bkg1: [No] 320.0 nm
Bkg2: [No] 400.0 nm

Number of replicates: 1
Flag standards over: 1.000% CV

Std #	Rep #	Std Conc	Calc Conc	Diff	Analyt abs	Bkg1 abs	Bkg2 abs	Net abs	Use
Read 1		0.0000	0.0001	0.0001	0.0001			0.0001	[Y]
Read 2		1.0210	1.0203	-0.0007	1.0201			1.0201	[Y]
Read 3		0.7320	0.7327	0.0007	0.7326			0.7326	[Y]
Read 4		0.5280	0.5284	0.0004	0.5283			0.5283	[Y]
Read 5									

BLANK [VIS ON] RediScan STATUS TIME DATE TEMP CELL
MATCH OFF [UV ON] RediRead DEVICES PrtScrn 08:04 10/01/96 N/A N/A

Single Component Analysis: Standards HELP

Samples DispStdCurve ViewStats DispScans Method SaveClear Print Quit

Standards file: A:\WORK_STD
Component name: 1626_10,20,30
Units: %T
Curve fit: Linear, zero intercept
Sampling device: None
Number of standards: 4
Read average time: 0.50 sec

Method name: A:\465_NIST
Analytical wl: 465.0 nm
Bkg1: [No] 320.0 nm
Bkg2: [No] 400.0 nm

Number of replicates: 1
Flag standards over: 1.000% CV

Std #	Rep #	Std Conc	Calc Conc	Diff	Analyt abs	Bkg1 abs	Bkg2 abs	Net abs	Use
Read 1		0.0000	0.0001	0.0001	0.0001			0.0001	[Y]
Read 2		0.9550	0.9550	0.0000	0.9540			0.9540	[Y]
Read 3		0.6860	0.6858	-0.0002	0.6851			0.6851	[Y]
Read 4		0.4810	0.4811	0.0001	0.4806			0.4806	[Y]
Read 5									

BLANK	[VIS ON]	RediScan	STATUS		TIME	DATE	TEMP	CELL
MATCH OFF	[UV ON]	RediRead	DEVICES	PrtScrn	08:11	10/01/96	N/A	N/A

Single Component Analysis: Standards HELP

Samples DispStdCurve ViewStats DispScans Method SaveClear Print Quit

Standards file: A:\WORK_STD
Component name: 1626_10,20,30
Units: %T
Curve fit: Linear, zero intercept
Sampling device: None
Number of standards: 4
Read average time: 0.50 sec

Method name: A:\546_NIST
Analytical wl: 546.0 nm
Bkg1: [No] 320.0 nm
Bkg2: [No] 400.0 nm

Number of replicates: 1
Flag standards over: 1.000% CV

Std #	Rep #	Std Conc	Calc Conc	Diff	Analyt abs	Bkg1 abs	Bkg2 abs	Net abs	Use
Read 1		0.0000	-0.0000	-0.0000	-0.0000			-0.0000	[Y]
Read 2		0.9850	0.9844	-0.0006	0.9850			0.9850	[Y]
Read 3		0.7070	0.7055	-0.0015	0.7059			0.7059	[Y]
Read 4		0.4940	0.4974	0.0034	0.4977			0.4977	[Y]
Read 5									

BLANK [VIS ON] RediScan STATUS TIME DATE TEMP CELL
MATCH OFF [UV ON] RediRead DEVICES PrtScrn 08:16 10/01/96 N/A N/A

Single Component Analysis: Standards HELP

Samples DispStdCurve ViewStats DispScans Method SaveClear Print Quit

Standards file: A:\WORK_STD
Component name: 1626_10,20,30
Units: %T
Curve fit: Linear, zero intercept
Sampling device: None
Number of standards: 4
Read average time: 0.50 sec

Method name: A:\590_NIST
Analytical wl: 590.0 nm
Bkg1: [No] 320.0 nm
Bkg2: [No] 400.0 nm
Number of replicates: 1
Flag standards over: 1.000% CV

Std #	Rep #	Std Conc	Calc Conc	Diff	Analyt abs	Bkg1 abs	Bkg2 abs	Net abs	Use
Read 1		0.0000	0.0001	0.0001	0.0001			0.0001	[Y]
Read 2		1.0370	1.0362	-0.0008	1.0356			1.0356	[Y]
Read 3		0.7430	0.7427	-0.0003	0.7423			0.7423	[Y]
Read 4		0.5270	0.5290	0.0020	0.5287			0.5287	[Y]
Read 5									

BLANK	[VIS ON]	RediScan	STATUS		TIME	DATE	TEMP	CELL
MATCH OFF	[UV ON]	RediRead	DEVICES	PrtScrn	08:20	10/01/96	N/A	N/A

Single Component Analysis: Standards HELP

Samples DispStdCurve ViewStats DispScans Method SaveClear Print Quit

Standards file: A:\WORK_STD
Component name: 1626_10,20,30
Units: %T
Curve fit: Linear, zero intercept
Sampling device: None
Number of standards: 4
Read average time: 0.50 sec

Method name: A:\635_NIST ↓ ↑
Analytical wl: 635.0 nm
Bkg1: [No] 320.0 nm
Bkg2: [No] 400.0 nm

Number of replicates: 1
Flag standards over: 1.000% CV

Std #	Rep #	Std Conc	Calc Conc	Diff	Analyt abs	Bkg1 abs	Bkg2 abs	Net abs	Use
Read 1		0.0000	0.0001	0.0001	0.0001			0.0001	[Y]
Read 2		0.9980	0.9979	-0.0001	0.9953			0.9953	[Y]
Read 3		0.7160	0.7156	-0.0004	0.7137			0.7137	[Y]
Read 4		0.5160	0.5166	0.0006	0.5153			0.5153	[Y]
Read 5									

BLANK [VIS ON] RediScan STATUS TIME DATE TEMP CELL
MATCH OFF [UV ON] RediRead DEVICES PrtScrn 09:20 10/01/96 N/A N/A

S. Department of Commerce
Malcolm Baldrige
Secretary

National Bureau of Standards
Ernest Ambler, Director

National Bureau of Standards

Certificate

Standard Reference Material 930D

Glass Filters for Spectrophotometry

This Standard Reference Material (SRM) is intended as a reference source for the verification of the transmittance and absorbance scales of spectrophotometers. SRM 930D consists of three individual glass filters in separate metal holders and one empty filter holder. The filter holders are provided with shutters that protect the glass filters when not in use. These shutters must be removed at the time of measurement and be replaced after the measurements have been completed. Each metal holder bears a filter number (10, 20, or 30) and a set identification number. The upper left corner of each filter has been removed to indicate correct orientation in the metal holder. The certified transmittance values are given below.

SRM 930D Filter Number & Set Ident.	TRANSMITTANCE (T)					TRANSMITTANCE DENSITY ($-\log_{10}T$)				
	Wavelength, nm (Spectral Bandpass, nm)					Wavelength, nm (Spectral Bandpass, nm)				
	440.0 (2.2)	465.0 (2.7)	546.1 (6.5)	590.0 (5.4)	635.0 (6.0)	440.0 (2.2)	465.0 (2.7)	546.1 (6.5)	590.0 (5.4)	635.0 (6.0)
10-1626	0.0952	0.1109	0.1035	0.0919	0.1005	1.021	0.955	0.985	1.037	0.998
20-1626	0.1852	0.2063	0.1963	0.1806	0.1922	0.732	0.686	0.707	0.743	0.716
30-1626	0.2962	0.3301	0.3205	0.2968	0.3047	0.528	0.481	0.494	0.527	0.516

Date of Certification: Feb 11, 1991

The uncertainty of the certified transmittance value is ±0.5 percent at the time of certification. This uncertainty includes the effects of the random and systematic errors of the calibration procedure, as well as possible transmittance changes of the filters during the period of calibration.

The transmittance values (T) can be converted to percent transmittance (%T) by multiplying by 100. The transmittance densities are calculated from the measured transmittance (T). These values should be indicated by the absorbance scale of the spectrophotometer if the filters are measured against air. The transmittance values given were measured against air at an ambient temperature of 22.5 °C.

Aging of the glass may cause some filters to change transmittance by about ±1 percent over a period of approximately one year from the date of calibration. Improper storage or handling of the filters may also cause changes [5]. It is recommended that the filters in the holders be handled only by the edges with soft plastic (polyethylene) gloves and optical lens tissue. When not in use they should be stored in their holders and in the container provided for this purpose. Extended exposure to laboratory atmosphere and dusty surroundings should be avoided. In cases where verification is desirable, the filters should be returned to the National Bureau of Standards for cleaning and recalibration.

The research, development, and initial production of this SRM were conducted by R. Mavrodineanu and J.R. Baldwin, NBS Inorganic Analytical Research Division.

The transmittance measurements were performed by R.W. Burke, M.V. Smith, and R. Mavrodineanu, NBS Inorganic Analytical Research Division. Technical leadership for the preparation and measurements leading to certification was provided by R.W. Burke.

The overall direction and coordination of the technical measurements leading to certification were performed under the chairmanship of J.R. DeVoe, NBS Inorganic Analytical Research Division.

The technical and support aspects involved in the preparation, certification, and issuance of this Standard Reference Material were coordinated through the Office of Standard Reference Materials by L.J. Powell.

Gaithersburg, MD 20899
August 15, 1984
(Revision of Certificate dated 8-1-77)

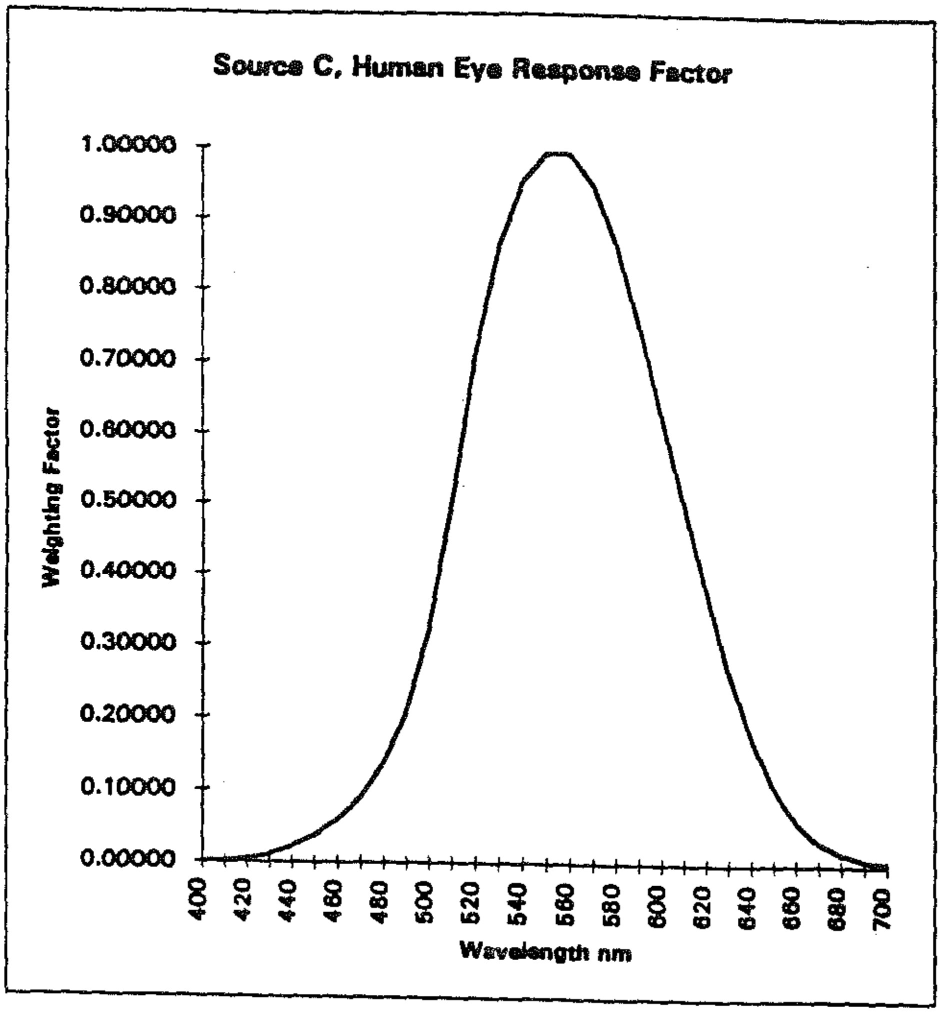
Stanley D. Rasberry, Chief
Office of Standard Reference Materials

(over)

Table Three

Photopic Response Curve

nm	factor
400	0.00040
410	0.00120
420	0.00400
430	0.01160
440	0.02300
450	0.03800
460	0.06000
470	0.09100
480	0.13900
490	0.20800
500	0.32300
510	0.50300
520	0.71000
530	0.86200
540	0.95400
550	0.99500
560	0.99500
570	0.95200
580	0.87000
590	0.75700
600	0.63100
610	0.50300
620	0.38100
630	0.26500
640	0.17500
650	0.10700
660	0.06100
670	0.03200
680	0.01700
690	0.00820
700	0.00410



Quarterly Neutral Density Filter Calibration

Forth Quarter, 1996

Optical Density	Tool No.	Tech	Date
0.0434	545	ERK	10/1/96
0.0429	563	ERK	10/1/96
0.0430	497	ERK	10/1/96
0.0509	521	ERK	10/1/96
0.0541	498	ERK	10/1/96
0.0546	541	ERK	10/1/96
0.0598	562	ERK	10/1/96
0.0929	848	ERK	10/1/96
0.1129	537	ERK	10/1/96
0.1288	530	ERK	10/1/96
0.1412	846	ERK	10/1/96
0.1913	544	ERK	10/1/96
0.2158	513	ERK	10/1/96
0.2254	520	ERK	10/1/96
0.2279	528	ERK	10/1/96
0.2867	561	ERK	10/1/96
0.2885	536	ERK	10/1/96
0.3353	532	ERK	10/1/96
0.3401	514	ERK	10/1/96
0.3476	543	ERK	10/1/96
0.3736	560	ERK	10/1/96
0.3760	518	ERK	10/1/96
0.4178	482	ERK	10/1/96
0.4864	546	ERK	10/1/96
0.4995	509	ERK	10/1/96
0.5153	538	ERK	10/1/96
0.5321	559	ERK	10/1/96
0.5371	531	ERK	10/1/96
0.5996	558	ERK	10/1/96
0.6253	542	ERK	10/1/96
0.6294	517	ERK	10/1/96
0.6373	540	ERK	10/1/96
0.6384	508	ERK	10/1/96
0.7360	512	ERK	10/1/96
0.7480	847	ERK	10/1/96
0.8350	534	ERK	10/1/96
0.8333	557	ERK	10/1/96
0.8456	539	ERK	10/1/96
0.8592	505	ERK	10/1/96
0.9305	511	ERK	10/1/96
0.9835	556	ERK	10/1/96
0.9848	522	ERK	10/1/96
1.0307	507	ERK	10/1/96
0.3168	499	ERK	10/1/96
0.5639	733	ERK	10/1/96
0.6963	734	ERK	10/1/96
0.0763	1457	ERK	10/1/96
0.2911	1469	ERK	10/1/96

EPA Opacity Design Specification Verification Procedure for Lear Siegler Measurement Controls Corporation Manufactured Opacity Monitors, Models 1100M, MC2000, MC2500

Document Number 80501071, Rev. 5 Effectivity Date - January 31, 1991

1.0 Test Parameters and Fixture Descriptions

1.0.1 Instrument Selection

.1 Randomly sample one analyzer for each month's production and perform the following tests. Section 2, Angle of View. Section 3, Angle of Projection . Section 4, Optical alignment Sight Test. Section 5, Spectral Response.

If this analyzer fails any of the test requirements, the month's production must be resampled according to the to military standard 105D sampling procedure (MIL-STD-105D) inspection level II. The sample must be determined acceptable under MIL-STD-105D procedures, to quality level 1.0.

1.1.0 Test Fixtures

.1 Calibration Rail System

The calibration rail system used in the opacity calibration area uses two 1/2" linear bearing shafts spaced 12.5" apart and attached to steel tables. The shafts are aligned to be level and true within .125" over the length of the table. Plates with four linear pillow blocks are used as surfaces along the shafts. A system of different fixtures has been developed that allows us to mount to the top surfaces of the plates and give us the ability to perform a variety of different opacity monitors with very little change over time.

.2 Rail Mount Test Fixture - Trans (LSMCC # 80501015)

This fixture is designed to mount the transceiver to the calibration rail used in the opacity set up area. The intent of this fixture is to allow the test personnel the ability to mount the transceiver in line with the calibration rails to perform the monthly EPA Opacity Specification Verification test. The fixture allows the transceiver to be mounted at standard position and rotated to 90°, 180°, and 270° allow for testing during the angle of view and angle of projection tests.

.3 Rail Mount Fixture - Reflector (LSMCC # 80501016)

This fixture is designed to mount to the calibration rail used in the

D. Light Source/Detector Assy (Part #80501035)

E. Rail Mount Test Fixture - Reflector (LSMCC Part #80501016)

2.1.0 Set up

.1 Install the rail mount test fixtures on the calibration rail #2 (30').

.2 Mount the Unit Under Test (UUT) on the rail mount transceiver test fixture, transceiver should be in the standard test position, which is 180° off standard mounting.
Position the fixture at the mark on the calibration rail scale.

.3 Install the light source/detector assembly on the rail mount fixture. Verify that it is set up of light source. Verify that both adjustments are set to zero, and that the top adjustment block is set properly. This sets the fixture center point.

.4 Position the light source assembly at the mark indicated on the calibration rail scale. (NOTE: This mark is set for a path of 3 meters, from the light source to the mounting8ng flange of the transceiver.

.5 Connect an DVM to TP1 in the stack power supply of the UUT. (Connect the return to the (-) side of C13.) This will monitor the UUT detector output.

.6 Apply power to the UUT.

.7 Apply power to the light source/detector assembly.

.8 Verify that the light source is lit.

.9 Verify, and or adjust the photo detector aperture plate so that the light from the source is centered in the aperture.

.10 Set the DVM to DC volts, set the scale to 10 VDC. Verify that reading is less than .5VDC> Record this value on the test data sheet.

2.2.0 Angle of View Test

Note: After rotating the transceiver at 90° intervals, use the gimcalibration rail scale. (NOTE: this mark is set for a path of 3 meters, from the detector to the mounting flange of the transceiver.)

.5 Connect a DVM to the TPI in the stack power supply of the test detector. (Connect the return to the (-) side of C13.) This will monitor the output of the test detector.

.6 Apply power to the UUT.

.7 Apply power to the test stack power supply.

.8 Verify that the light pattern is centered on the light source/detector assembly.

.9 Set the DVM to DC volts, set the scale to 10VDC. Verify the reading is less than 4.0 VDC. If reading is above this, adjust the lamp duty cycle to lower light output.

.10 Place a black cloth over the front of the UUT light path and take a reading. Record this value on the test data sheet.

3.2.0 Angle of Projection Test

Note: After rotating the transceiver at 90°intervals, use the gimballed transceiver fixture to re-center the light pattern from the UUT.

.1 Adjust the left to right adjustment on the light source/detector rail assembly to the 2.5cm mark, and adjust the front to back adjustment to the 2.5cm mark. Record the output detector on the test data sheet in the row for left direction.

.2 Continue making adjustments at 2.5cm intervals and record the detector output at each point. Stop at the 30cm point.

.3 Return both adjustments back to zero.

.4 Rotate the transceiver 90°, clockwise to the 90°position.

.5 Repeat steps 3.2.1 through 3.2.3 for the down direction.

.6 Rotate the transceiver 90°, clockwise to the 180°position.

.7 Repeat steps 3.2.1 through 3.2.3 for the right direction.

.8 Rotate the transceiver 90°, clockwise to the 270°position.

.1 Using the horizontal adjustment on the transceiver rail mount test fixture, adjust horizontally until the system output changes 2% opacity.

.2 Place the instrument in align position and verify that there is an indication of misalignment, as defined in the operations manual.

.3 Return the horizontal adjustment to zero.

4.3.0 Optical Alignment Sight Test - Lateral

.1 Using the adjustment on the transceiver rail mount test fixture, adjust laterally until the system output changes 2% opacity.

.2 Place the instrument in align position and verify that there is an indication of misalignment, as defined in the operations manual.

.3 Return the lateral alignment adjustment to zero.

4.4.0 Optical alignment Sight Test - Reflector Alignment

.1 Using the lateral adjustment on the reflector rail mount fixture, adjust laterally until the system output changes 2% opacity.

.2 Place the instrument in align position and verify that there is and indication of misalignment, as defined in the operations manual.

.3 Return the lateral adjustment to zero.

5.0 Spectral Response Test

5.0.1 Equipment Required

A. Oscilloscope

B. Standard DVM (Fluke Model 85 or equivalent)

C. 1100M System with power supply, control unit, and pre-aligned transceiver.

D. Standard Test Cables

E. Spectral Response Fixture (LSMCC Part #80501036)

I. GENERAL DESCRIPTION DATA SHEET

(*Enter the following information. This will be automatically entered in the cert. report.)

1	Customer name	THE HOOVER COMPANY			
2	Installation Site (address)	101 E. MAPLE STREET			
3	Facility Location (city,state)	NORTH CANTON, OH.			
4	Instrument Manufacturer	MONITOR LABS			
5	Instrument Model Number	LS541			
6	Transceiver Serial Number	LS541-0428			
7	Control Unit Serial Number	LS541-0428			
8	Power Supply Serial Number	LS541-0428			
9	Reflector Serial Number	LS541-0428			
10	Date Instrument Tested	15-Oct-96			
11	Monitoring Pathlength, L1 (0.305m=1ft.)	1.82436	m.	/ ft.	5.97921
12	Emission Outlet Pathlength, L2	2.44000	m.	/ ft.	8.0000
13	Flange to Flange Dimension	2.44000	m.	/ ft.	8.0000
14	O.P.L.R.	0.669			
15	Instrument Span (% opacity)	100	%		
16	Test Unit Serial Number	LS541-0426			
17	Date Test Unit Manufactured	10-Sep-96			
18	Date Test Unit Tested	19-Sep-96			
19	Test Unit Testing Conducted By:	ERNEST RAY KILLIAN			
20	Optical Alignment Test (pass/fail)	pass			
21	Recorder Manufacturer	CHESSELL			
22	Recorder Model Number	300E TOOL# 942			
23	Recorder Serial Number	9101-1523			
24	Sales Order Number	K06344B			
25	Work Center Number (MSS #)	MSS767			
26	Top Assembly Number	80540351-2			
27	Certification Number	SEE REV-A			
28	RGR Number				
29	Person Conducting Calibration Test:	ERNEST RAY KILLIAN			

30 Notes:

Quarterly Neutral Density Filter Audit

FOURTH QUARTER, 1996
CAL DUE DATE 01-01-1997

Optical Density	Tool No.	Opacity %
0.0429	563	12.376
0.0430	497	12.403
0.0434	545	12.511
0.0509	521	14.508
0.0541	498	15.347
0.0546	541	15.477
0.0598	562	16.820
0.0763	1457	20.941
0.0929	848	24.881
0.1129	537	29.368
0.1288	530	32.743
0.1412	846	35.263
0.1913	544	44.519
0.2158	513	48.551
0.2254	520	50.050
0.2279	528	50.433
0.2867	561	58.643
0.2885	536	58.871
0.2911	1459	59.199
0.3168	499	62.304
0.3353	532	64.392
0.3401	514	64.914
0.3476	543	65.715
0.3736	560	68.353
0.3760	518	68.586
0.4178	482	72.381
0.4864	546	77.640
0.5153	538	79.544
0.5321	559	80.576
0.5371	531	80.873
0.5639	733	82.388
0.5995	509	84.217
0.5996	558	84.222
0.6253	542	85.422
0.6294	517	85.605
0.6373	540	85.951
0.6384	508	85.999
0.6963	734	88.285
0.7360	512	89.633
0.7480	847	90.010
0.8332	557	92.315
0.8350	534	92.358
0.8456	539	92.603
0.8592	505	92.907
0.9305	511	94.305
0.9835	556	95.163
0.9848	522	95.182
1.0307	507	95.817
		0.000
		0.000
		0.000
		0.000
		0.000
		0.000
		0.000

PRELIMINARY CERTIFICATION REPORT

Customer name	THE HOOVER COMPANY
Installation Site (address)	101 E. MAPLE STREET
Facility Location (city,state)	NORTH CANTON, OH.
Instrument Manufacturer	MONITOR LABS
Instrument Model Number	LS541
Transceiver Serial Number	LS541-0428
Monitoring Pathlength, L1	1.824363 m.
Emission Outlet Pathlength, L2	2.44 m.
Flange to Flange Dimension	2.440 m.
O.P.L.R.	0.669
Recorder Manufacturer	CHESSELL
Recorder Model Number	300E TOOL# 942
Recorder Serial Number	9101-1523

Ideal Neutral Density Filters:

Low	0.075
Mid	0.299
High	0.673

Calibration Error test Data:

(*Enter data in "Instrument Output".)

Run No.		Instrument Output
0	zero	
1	low	
2	mid	
3	high	
4	low	
5	mid	
6	high	
7	low	
8	mid	
9	high	
10	low	
11	mid	
12	high	
13	low	
14	mid	
15	high	
16	zero	

Response Time Test Data:

(*Enter "Upscale" and "Downscale" values.)

	Upscale	
1		seconds
2		seconds
3		seconds
4		seconds
5		seconds

	Downscale	
1		seconds
2		seconds
3		seconds
4		seconds
5		seconds

Quarterly Neutral Density Filter Audit

FOURTH QUARTER, 1996
CAL DUE DATE 01-01-1997

Optical Density	Tool No.	Opacity %
0.0429	563	12.376
0.0430	497	12.403
0.0434	545	12.511
0.0509	521	14.509
0.0541	498	15.347
0.0546	541	15.477
0.0598	562	16.820
0.0763	1457	20.941
0.0929	848	24.882
0.1129	537	29.369
0.1288	530	32.744
0.1412	846	35.264
0.1913	544	44.520
0.2158	513	48.552
0.2254	520	50.051
0.2279	528	50.434
0.2867	561	58.644
0.2885	536	58.873
0.2911	1459	59.201
0.3168	499	62.305
0.3353	532	64.393
0.3401	514	64.915
0.3476	543	65.716
0.3736	560	68.355
0.3760	518	68.588
0.4178	482	72.382
0.4864	546	77.642
0.5153	538	79.546
0.5321	559	80.577
0.5371	531	80.874
0.5639	733	82.389
0.5995	509	84.218
0.5996	558	84.223
0.6253	542	85.423
0.6294	517	85.606
0.6373	540	85.952
0.6384	508	86.000
0.6963	734	88.286
0.7360	512	89.634
0.7460	847	90.010
0.8332	557	92.316
0.8350	534	92.358
0.8456	539	92.604
0.8592	505	92.907
0.9305	511	94.305
0.9835	556	95.163
0.9848	522	95.182
1.0307	507	95.817
		0.000
		0.000
		0.000
		0.000
		0.000
		0.000
		0.000

PRELIMINARY CERTIFICATION REPORT

Customer name	THE HOOVER COMPANY	
Installation Site (address)	101 E. MAPLE STREET	
Facility Location (city,state)	NORTH CANTON, OH.	
Instrument Manufacturer	MONITOR LABS	
Instrument Model Number	LS541	
Transceiver Serial Number	LS541-0428	
Monitoring Pathlength, L1	1.8243	m.
Emission Outlet Pathlength, L2	2.44	m.
Flange to Flange Dimension	2.440	m.
O.P.L.R.	0.669	
Recorder Manufacturer	CHESSELL	
Recorder Model Number	300E TOOL# 942	
Recorder Serial Number	9101-1523	

Ideal Neutral Density Filters:

Low	0.075
Mid	0.299
High	0.673

Calibration Error test Data:

(*Enter data in "Instrument Output".)

Run No.		Instrument Output
0	zero	0.1
1	low	16.4
2	mid	60.0
3	high	85.3
4	low	16.4
5	mid	60.0
6	high	85.2
7	low	16.4
8	mid	60.0
9	high	85.3
10	low	16.8
11	mid	60.1
12	high	85.1
13	low	16.4
14	mid	60.0
15	high	85.3
16	zero	0.1

Response Time Test Data:

(*Enter "Upscale" and "Downscale" values.)

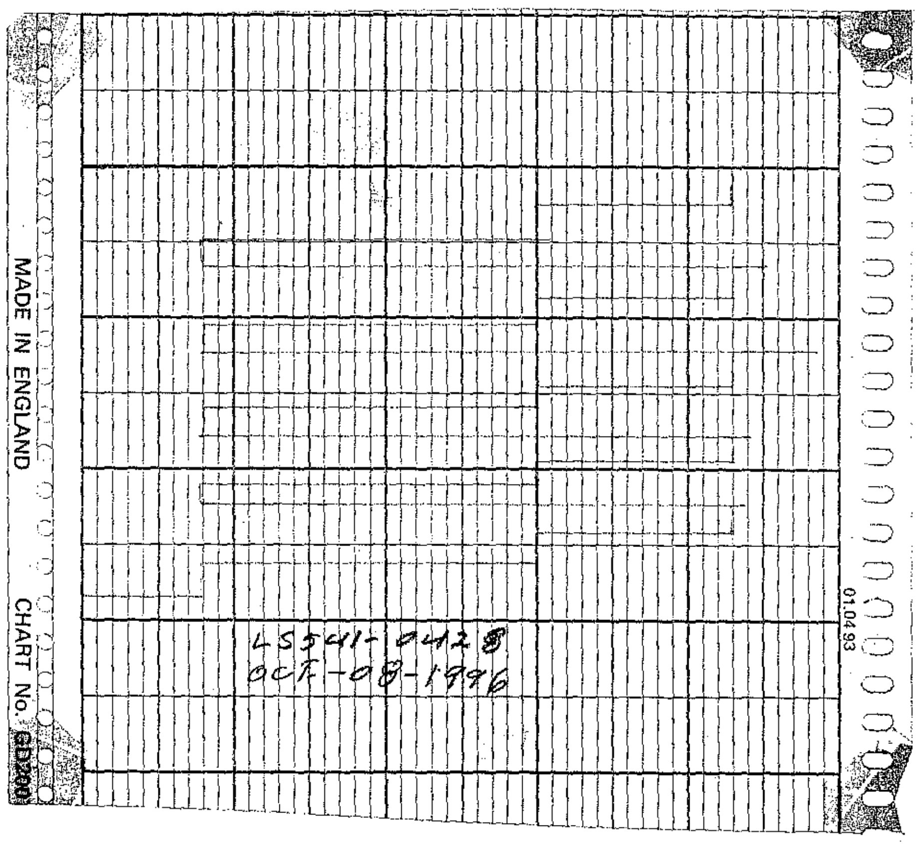
	Upscale	
1	1.8	seconds
2	2.0	seconds
3	1.7	seconds
4	2.1	seconds
5	2.0	seconds

	Downscale	
1	2.8	seconds
2	3.0	seconds
3	2.9	seconds
4	3.3	seconds
5	3.1	seconds

CALIBRATION ERROR TEST

INSTRUMENT SN: LS541-0428

DATE: 15-Oct-96



CALIBRATION ERROR TEST

INSTRUMENT SN: LS541-0428

DATE: 15-Oct-96

LS541

Customer: HOOVER COMPANY MAIN PLANT Date: OCT / 15 / 1996

Location: 101 E MAPLE STREET S.O.: K06344B

Preliminary Setup Checklist:

X EPROM Version: REV-6.3 REL-4

X Stack I.D.: 5 Ft. 11.75 In. 1.8243 M

X Stack Exit I.D.: 8 Ft. 0 In. 2.44M

Mounting Flange to Flange Distance: 8 Ft. 0 In. 2.44M

X OPLR .68

X Check Current Output Circuits 4-20 1 4-20 2 0-1 3 4-20 4

___ Zero and Span Unit

X Perform Filter and Response Time Test

X Misalignment Test [Most negative] 0 L 0 R 0 U -1.1 D

Measurements as taken from 80540307 PC Board:

Reference Signal (From transceiver) TP1 (Brown) 52 mV

Measurement Signal (From transceiver) TP4 (Yellow) 52 mV

Auto Calibration Check Values:

Zero Calibration Point: 000.1 % Opacity

Span Calibration Point: 023.1 % Opacity

Type of Reflector:

___ Scotchlite

X Plastic

___ Glass

Serial #: LS541-0428

Technician: Ernest Ray Killian

Q.A. Audit:

LS541™ Customer Information

Customer: THE HOOVER COMPANY Date: OCT / 15 / 1996

Location: MAIN PLANT 101 E MAPLE STREET S.O.: K06344B

Serial Number: LS541-0428

EPROM Version: REV-6.3 REL-A

Stack I.D.: 5 Ft. 11.75 In. 1.8243M

Stack Exit I.D.: 8 Ft. 0 In. 2.44M

Mounting Flange to Flange Distance: 8 Ft. 0 In. 2.44M

OPLR: .68

Power: 115 VAC @ (50/60) Hz

Current Loops:

1 4 - 20 MA 2 4 - 20 MA 3 0 - 1 MA 4 4 - 20 MA

Specials: ______

Zero Calibration Point: 000.1 % Opacity

Span Calibration Point: 023.1 % Opacity

Type of Reflector:

____ Scotchlite

X Plastic

____ Glass

LS541-0428
OCT. 15, 1996

MONITOR LABS, INC.
LS541 OPACITY MONITOR, COPYRIGHT 1994
SERIAL NUMBER 428
UNIT 1
YEAR 96

ORIGINAL OPLR 0.68 10/07/96
CURRENT OPLR 0.68 10/07/96

10:06 10/15
CAL START
ZERO CAL CYCLE
NOMINAL 0.1

10:07 10/15
NO FAILURES
:OK
CAL END

0 10:07 10/15
1OPAC 0.1 FAST

10:07 10/15
1OPAC 10.0 FAST

1 10:07 10/15
1OPAC 16.4 FAST

10:07 10/15
1OPAC 47.2 FAST

10:07 10/15
2 1OPAC 60.0 FAST

10:07 10/15
1OPAC 76.5 FAST

10:07 10/15
3 1OPAC 85.3 FAST

10:07 10/15
1OPAC 72.2 FAST

10:07 10/15
4 1OPAC 16.4 FAST

10:07 10/15
1OPAC 44.8 FAST

5 10:07 10/15
1OPAC 60.0 FAST

10:07 10/15
1OPAC 72.5 FAST

10:07 10/15
6 1OPAC 85.2 FAST

10:07 10/15
1OPAC 69.2 FAST

7 10:08 10/15
1OPAC 16.4 FAST

LS541—0428
OCT. 15, 1996

10:08 10/15
10PAC 40.0 FAST

8 10:08 10/15
10PAC 60.0 FAST

10:08 10/15
10PAC 70.0 FAST

9 10:08 10/15
10PAC 85.3 FAST

10:08 10/15
10PAC 72.0 FAST

10 10:08 10/15
10PAC 16.8 FAST

10:08 10/15
10PAC 38.2 FAST

11 10:08 10/15
10PAC 60.1 FAST

10:08 10/15
10PAC 72.5 FAST

12 10:08 10/15
10PAC 85.3 FAST

10:08 10/15
10PAC 70.4 FAST

13 10:08 10/15
10PAC 16.4 FAST

10:08 10/15
10PAC 39.0 FAST

14 10:08 10/15
10PAC 60.0 FAST

10:09 10/15
10PAC 73.7 FAST

15 10:09 10/15
10PAC 85.3 FAST

10:09 10/15
10PAC 65.2 FAST

16 10:09 10/15
10PAC 0.1 FAST

PAGE 1 OF 1
LS541-0428
OCT. 15, 1996

MONITOR LABS, INC.
LS541 OPACITY MONITOR, COPYRIGHT 1994
SERIAL NUMBER 428
UNIT 1
YEAR 96

ORIGINAL OPLR 0.68 10/07/96
CURRENT OPLR 0.68 10/07/96

10:16 10/15
CAL START
ZERO CAL CYCLE
COPAC 0.4
1OPAC 0.4
CAL DRIFT 0.3
ZERO COMP 0.3
NOMINAL 0.1

10:19 10/15
NO FAILURES
:OK
CAL END

10:19 10/15
CAL START
SPAN CAL CYCLE
COPAC 23.5
1OPAC 23.5
CAL DRIFT -000.0
SPAN COMP -000.0
NOMINAL 23.1

10:22 10/15
NO FAILURES
:OK
CAL END

10:28 10/15
1OPAC 0.1 SLOW

10:34 10/15
1OPAC 0.1 SLOW

10:40 10/15
1OPAC 0.1 SLOW